THE SIOUX CITY BRIDGE.

comprising such works as, from their rarity or value, should not be lent out, all unbound periodicals, and such text books as ought to be found in a library of reference except when required by Committees of the Institute, or by members or holders of second class stock, who have obtained the sanction of the Committee. The second class shall include those books intended for circulation.

ARTICLE VI.—The Secretary shall have authority to loan to Members and to holders of second class stock, any work belonging to the SECOND CLASS, subject to the following regulations:

Section 1.—No individual shall be permitted to have more than *two books* out at one time, without a written permission, signed by at least two members of the Library Committee; nor shall a book be kept out more than two WEEKS; but if no one has applied for it, the former borrower may renew the loan. Should any person have applied for it, the latter shall have the preference.

Section 2.—A FINE OF TEN CENTS PER WEEK shall be exacted for the detention of a book beyond the limited time; and if a book be not returned within three months it shall be deemed lost, and the borrower shall, in addition to his fines, forfeit its value.

Section 3.—Should any book be returned injured, the borrower shall pay for the injury, or replace the book, as the Library Committee may direct; and if one or more books, belonging to a set or sets, be lost, the borrower shall replace them or make full restitution.

ARTICLE VII.—Any person removing from the Hall, without permission from the proper authorities, any book, newspaper or other property in charge of the Library Committee, shall be reported to the Committee, who may inflict any fine not exceeding twenty-five dollars.

ARTICLE VIII.—No member or holder of second class stock, whose annual contribution for the current year shall be unpaid or who is in arrears for fines, shall be entitled to the privileges of the Library or Reading Room.

ARTICLE IX.—If any member or holder of second class stock, shall refuse or neglect to comply with the foregoing rules, it shall be the duty of the Secretary to report him to the Committee on the Library.

ARTICLE X.—Any Member or holder of second class stock, detected in mutilating the newspapers, pamphlets or books belonging to the Institute shall be deprived of his right of membership, and the name of the offender shall be made public.

THE SIOUX CITY BRIDGE.

A REPORT

To MARVIN HUGHITT, President of the Sioux City Bridge Company,

BY

GEORGE S. MORISON, Chief Engineer.

SUBJECTS.

APPENDICES.

PLATES.

1891

CHICAGO, May 1, 1890.

MARVIN HUGHITT, ESQ.,
President Sioux City Bridge Co.,

Dear Sir:—

I submit the following final report in relation to the construction of the bridge across the Missouri River at Sioux City.

Yours truly,

GEORGE S. MORISON,
Chief Engineer.

THE SIOUX CITY BRIDGE.

I.

PRELIMINARY NARRATIVE.

The charter authorizing the construction of a bridge across the Missouri River at Sioux City was granted by an Act of Congress approved August 15, 1876. This charter is given in Appendix B.

No active steps were taken with reference to the construction of this bridge till January, 1885, when I was requested by the officials of the Sioux City Bridge Co. to examine the location and make a report with reference to the building of this bridge. During the winter of 1884-1885 borings and surveys were made. The results of these surveys were embodied in the reports made to Mr. Francis B. Parker, who was then President of the Sioux City Bridge Co. In this report I recommended the construction of a bridge at the foot of Kansas Street, this being west of the business portion of Sioux City, the railroad approach to the bridge to be by a viaduct built in Third Street. I also considered the alternative plan of a bridge below the city at Sawyer's Bluff.

Nothing further was done with reference to the construction of this bridge till the early part of 1887, when I was again requested to visit Sioux City with reference to the actual construction of the bridge. On the second of March I met some gentlemen interested in the Sioux City Bridge Co. at Sioux City and learned from them that the difficulties of getting the right of way for the approach to the bridge at the foot of Kansas Street were so great that they considered it necessary to adopt the lower location, below the city at Sawyer's Bluff. On the following day I definitely fixed the location on which the bridge has since been built.

On April 14, 1887, I submitted the plans of the proposed bridge to the Secretary of War for approval with the various documents required by the rules of the Department.

On May 9, 1887, the limits of the city of Sioux City were extended and the east end of the bridge was included within the city limits. Proceedings were begun with reference to having a tax voted by the city in aid of the construction of the bridge.

On May 11, 1887, the parties who controlled the Sioux City Bridge Co. entered into an agreement to transfer their interests to the Chicago and Northwestern and the Chicago, St. Paul, Minneapolis and Omaha Railway Companies. This agreement was carried out on the 6th of June by a reorganization of the Company by the election of a new Board of Directors and officers. At the same time I received instructions from you as President of the Company to proceed at once with the construction of the bridge.

On the 6th of June, 1887, a letter was sent to me by the Hon. William C. Endicott, Secretary of War, enclosing an instrument in duplicate indicating his approval of the plans which I submitted to him on the 14th of April. This instrument, a copy of which is given in Appendix B, was duly executed on behalf of the Sioux City Bridge Co. on the 10th of June, and on behalf of the Secretary of War on the 14th of June.

On May 1, 1887, a professional partnership for the period of two years was formed between myself and Mr. E. L. Corthell under the firm name of Morison & Corthell. During the existence of this partnership the work at Sioux City was handled by the firm under the title of Morison & Corthell, Chief Engineers of the Sioux City Bridge.

Mr. Emil Gerber was appointed Resident Engineer, and on June 15 he went to Sioux City and took charge of the work.

On August 22, 1887, a contract was closed with T. Saulpaugh & Co. for the construction of the Masonry.

On August 9, 1887, a contract was executed with the Union Bridge Co. for the manufacture of the Superstructure.

On January 31, 1888, a contract was executed with the firm of Baird Bros. for the erection of the Superstructure.

From the middle of November, 1887, till the end of the following April, I was absent from the country and the supervision of the work devolved upon Mr. E. L. Corthell.

The work was prosecuted without interruption and the erection of the last span was completed on the 20th day of November, 1888.

The first train crossed the bridge on November 26, 1888. On the 5th of December, the bridge was formally tested and the occasion celebrated by a banquet at the Hotel Booge.

The entire charge of the bridge was turned over to the Operating Department of the Chicago, St. Paul, Minneapolis and Omaha Railway on August 8, 1889.

II.

GENERAL DESCRIPTION.

The Sioux City Bridge is a single track railroad bridge.

As originally designed it consisted of three spans of 400 feet each, resting on masonry piers with a plate girder span extending from the east pier to the bluff, and with a short deck span connecting the west pier with the west approach. The piers were numbered from east to west.

Pier I was located about 270 feet from the shore, back of the track of the Sioux City and Pacific R. R., and close to the base of the bluff. For many years the channel had been along the east shore on this portion of the river and had been gradually cutting away the shore. This cutting still continues and it was thought that by locating the pier at this distance from the shore it would be unnecessary to spend anything to prevent this cutting for several years and that when any protection work was required that protection would only be what would be needed at any rate to maintain the track of the Sioux City and Pacific R. R.

The three spans of 400 feet each made a practical opening of the bridge between the present shore line and the west pier of more than 900 feet, which opening would be gradually increased to more than 1100 feet by the wearing away of the east bank; the

width thus provided is greater than experience has shown to be necessary at any point on the river above Kansas City, where the channel has remained fixed for a long series of years.

About a mile and a half from the bridge and immediately in front of Sioux City the channel is of very variable character, shifting from side to side of the river; the current, wherever it may be above, strikes the east bank before reaching the bridge. The portion of Sioux City next to the river is built on bottom land and when the channel has been next to this shore it has cut badly into this bottom land. A little above the mouth of the Floyd River there is a considerable deposit of gumbo in this bottom land which has cut away very slowly, leaving a projecting point which has caused a temporary local disturbance.

During the summer of 1887 the channel followed the Iowa shore and was deflected by this gumbo point; the channel then went to the Nebraska shore, striking that shore a little above the bridge line. The result was that in the winter of 1888 the channel was on the west side of the river instead of in its accustomed place on the east side and the greater part of the bridge was left over dry land. To accommodate this condition it was decided to increase the length of the bridge by the addition of another 400 ft. span west of the three originally contemplated.

This change in plan was made in December, 1887.

The bridge as built consists of four spans of 400 feet each resting on masonry piers, and a plate girder span 61 ft. 6 in. long east of Pier I the total length from out to out of steel work being 1675 feet.

In one respect the Sioux City Bridge differs materially from other bridges which have been built on the Missouri River. The piers are not founded on rock, nor is there any available rock to be found in this location. The bluffs east of the river rest on a prealluvial gravel which extends under the river, and the piers are founded in this gravel to a depth of fifty feet below the alluvial deposit. This is clearly shown on Plate 4, on which the apparent limit of scour is shown, this representing the dividing line between the alluvial sand and the prealluvial gravel, and on which the line of maximum scour observed during the construction of the bridge is also shown. The piers are not founded in the alluvial deposit of the Missouri River, but are on an entirely different class of material, which is permanent in character and is the same material that forms the foundation of the bluffs. I say this specially for the reason that the statement has been made that these piers are founded in the alluvium of the Missouri River, which is entirely incorrect.

The east approach is 1.65 miles long from its connection with the main line of the Chicago, St. Paul, Minneapolis and Omaha Railway track to the east end of the bridge. The west approach is 1.92 miles long from Pier V to its connection with the Chicago, St. Paul, Minneapolis & Omaha Railway track in the bottom land west of the river. The Sioux City Bridge Company also owns a second connecting track 0.18 miles long used in reaching the Sioux City passenger station. The total mileage of track owned by the Sioux City Bridge Company is 4.044.

The only rectification work done consists in building a small piece of dike above the bridge on the west side, this being put in with reference to controlling the river in case the channel should again be thrown by some temporary disturbance towards the west side.

During the progress of the work all levels were referred to the benches established by the Missouri River Commission, the datum being the St. Louis City Directrix, which is 412.71 feet above the sea level.

III.

SUBSTRUCTURE.

THE substructure comprises a small abutment at the east end of the bridge and five piers; these piers are numbered from east to west.

Pier I has a pile foundation; the other four piers are founded on pneumatic caissons of the following dimensions:

Pier II.	28 by 60 by 18 feet.
Pier III.	28 by 60 by 18 "
Pier IV.	28 by 60 by 18 "
Pier V.	23 by 50 by 15 "

The caissons are built of pine timber with oak sills and iron cutting edges, planked with two thicknesses of three inch pine plank. The caissons are all surmounted by timber cribs, those of Piers II, III and IV having the corners cut off so as to make them of octagonal section, and that on Pier V being of rectangular section. The cribs are built of pine timber planked with one thickness of pine plank, the corners of Piers II, III and IV being plated with ¾-inch iron. Both the caissons and cribs were filled with Portland cement concrete.

The foundations were all put in by the company's own men under the direction of the Resident Engineer.

The caissons were built in position on pile false work and lowered on long screws to the bottom of the river.

The pneumatic machinery was first set up on the east side of the river immediately north of the bridge line; in the spring of 1888 it was transferred to the west side of the river and set up there, also north of the bridge line.

A temporary pile bridge was built in 1887 fifty feet north of the bridge line extending entirely across the river. A service track was laid across this bridge and it was used for the handling of material and to carry the pipes leading air and water to the caissons. In 1888 a similar pile bridge was built extending from the west shore as far as Pier IV.

PIER I.

Pier I being located on the shore at considerable distance from the river, was the least exposed of the foundations; work upon it therefore was made subservient to all other work and it progressed in a somewhat desultory manner.

The excavation of the pit for Pier I was begun with a small force August 5, 1887, the general elevation of the ground averaging 686.

The excavation was carried to elevation 674, when so much water was encountered that it became necessary to pump and to confine the sides of the pit with sheet piling. The material was at first a loam mixed with a little sand, probably washings from the bluffs, but at about elevation 677 a clean coarse sand was encountered, which proved well adapted for masonry and which was used in Piers I and II. The driving of sheet piling was begun October

11, and completed November 3, when excavation was resumed. The pit was excavated to elevation 664. On the 16th of January, 1888, pile driving was begun and this was continued with many intermissions till the work was completed on March 6. It was found that no matter what the elevation of the water in the river, enough water came into this pit from the land side in a single night to raise the water to elevation 674. The piles were cut off at elevation 665, and capped with two courses of 12″ by 18″ oak timber. On the 9th of March the foundation was ready for the masonry.

The masonry was begun on the 14th of March, stopped on the 17th, for want of stone, resumed on April 10, and the pier finished on April 21. The pit was filled at once to elevation 680 and subsequently to elevation 690, being the elevation of the Sioux City and Pacific track.

PIER II.

The service bridge was begun August 9, 1887, and on the 29th of August it had been built 150 feet west of Pier II.

The driving of the piles for the staging of the pier was begun August 27, and the piles had been all driven and capped on September 9. On September 10, an unusual flood occurred and during the night the flood carried away 100 feet of this bridge, six bents being washed out, and twelve piles were washed out of the staging. The flood was as short as it was sudden and all damage was repaired so that both the staging and bridge were ready for use on September 28. This accident did not cause any serious delay, as the cutting edge for the pier did not arrive till October 13, and the last of the oak sills did not come till the 18th.

The erection of the caisson was begun on the 21st of October and completed November 14. The caisson was lowered to the water's edge on the 17th, and concreting began on the 19th.

On November 20, the caisson was landed in about seven feet of water at elevation 661 and air pressure put on, a temporary air lock having been improvised which was used till the regular air lock arrived on the 28th. The caisson was filled with concrete to the top November 23; the crib work above the caisson proper was begun the same day. On the 6th of December it was completed and ready for the masonry. Masonry was begun after a few days' delay, December 11, and the work of sinking was resumed two days later. At elevation 618 a quantity of clay was encountered, generally in large lumps, varying from one to five feet in thickness and sometimes as large as 20 feet by 15 feet, the spaces between the clay being filled with sand, gravel and boulders. This mass of clay and boulders continued to elevation 606, the amount of clay decreasing towards the bottom. Most of the clay could be puddled and pumped out with the pumps, but the gravel was hoisted out. From elevation 606 to 597, the material was a medium sand mixed with some gravel; below this the proportion of gravel increased and some boulders were found.

The caisson reached its final position on January 12, 1888, the elevation of the cutting edge being 579.47 or 0.53 lower than the proposed depth.

The sealing of the working chamber was begun January 13, and proceeded slowly, the sealing not being completed till the 23d.

The laying of masonry was resumed February 10, and the pier carried only to the starling coping. Nothing further was done till June 12, when the laying of masonry was again resumed and the pier completed June 23.

During the spring of 1889 a large amount of riprap was put around this pier.

PIER III.

On December 7, the extension of the pile bridge towards Pier III was begun, and December 31 the driving of the piles of the staging for Pier III was begun.

The cutting edge was set up January 9, 1888, the caisson completed and the lowering begun January 30. January 31, the caisson was lowered on the bottom at elevation 666.5 in four feet of water. Concreting was begun that day and air pressure put on February 2. The concreting of the caisson was finished February 4, and the concrete filling of the crib February 12; masonry was begun February 15.

The material through which the caisson passed was a fine sand to elevation 638. A mass of mud, snags, gravel and boulders was then encountered extending to elevation 630. Below this was a comparatively coarse gravel. At elevation 620 the material changed to a clean coarse sand suitable for masonry. At elevation 605 this sand was mixed with gravel and at elevation 595 the amount of gravel became so large as materially to reduce the rate of progress.

The pier reached its final elevation at 580.95 March 15, 1888, and the sealing of the caisson was begun the next day.

On the 18th, the sealing being still unfinished, the flood, which always accompanies the breaking up of the ice, began and the water rose extremely high. For several days nothing could be done except to save material from the wrecked service bridge. The ice gorged near the bridge and the general break-up did not take place till April 2.

On the 16th of April, the pneumatic machinery was put on the old steamer *President;* on the 22d, the boat was towed to Pier III and air pressure was put on on the 24th; everything was found to be in good order and the work of sealing was resumed. On the 26th, the work was somewhat delayed by a strike of the pressure men, but the sealing was completed on the evening of May 6, and air pressure taken off the next day. The laying of masonry was resumed May 23, and the pier finished June 10, 1888.

PIER IV.

The pile bridge was extended east from the west shore to the site of Pier IV in July, 1888, and the staging for the caisson was begun July 21.

The cutting edge was placed July 31, and the caisson lowered on August 21, and landed in five feet of water at elevation 667 on the following day.

Concreting was begun on the 22d, air pressure put on on the 23rd and the sinking begun; the concrete filling of the caisson was completed August 25, and that of the crib September 3.

Above elevation 637 the material passed through was a fine sand; at elevation 627 it changed to a mixture of coarse sand, gravel and mud; at 630 the gravel became coarser and there was less mud; at 621 the gravel ceased and a medium sand continued to 608, occasional boulders being found with this sand; at 608 a mixture of sand and clay was encountered extending to 600, then came three feet of sand; from 597 to 588 a coarse sand and gravel were found in which a single lump of hard clay containing nearly 20 cubic yards was met. Below 588 the material was a fine sand.

On October 1, the caisson reached its final elevation at 580.48 and sinking was suspended.

The sealing of the working chamber was begun October 3, and completed on October 10. The laying of masonry was resumed on the 11th, and the pier finished at noon of the 24th.

PIER V.

The foundation of Pier V was put in before that of Pier IV.

A pile bridge was built from the west shore to the site of this pier and construction of the staging was begun May 9. The cutting edge was set up on May 14, and the caisson completed and lowered into position on June 13, the work having been suspended twelve days by my special orders. The caisson was lowered on the bottom at elevation 667 in eleven feet of water.

The water was high and there was a considerable current at this pier, so it became necessary to stop the cutting away of the sand bank by the use of sand bags. Air pressure was put on on the 14th of June, but for two days the principal work consisted in getting a proper bearing under the cutting edge and the sinking did not actually begin till the 16th.

The material passed through was sand to elevation 643, where it changed to a soft blue mud which continued to elevation 637. From 637 to 627 the same mud continued, but it was more or less mixed with sand. From 627 to 624 the sand was thoroughly clean; at 624 it changed to a coarse gravel, under which was found a layer of clay at elevation 623. This layer of clay was four feet thick and showed signs of stratification; under it were two feet of coarse sand. At elevation 617 another layer of blue clay was struck, this clay not being stratified, which continued to the bottom of the foundation.

In sinking this caisson, a clay hoist which had previously been used to great advantage at the Rulo Bridge was used to remove such material as could not be pumped.

The caisson reached its final position July 28, the material under the middle of the caisson being left one foot above the cutting edge for a space thirteen by forty feet.

The sealing of the working chamber was begun July 30, and completed August 2.

Work on the masonry was resumed August 9, and the pier completed on the 29th.

During the month of September an earth embankment was built from the high shore line and level with it to Pier V, to form a base for the trestle. It was made of the necessary width to form the base of a future embankment. The exposed slopes of this embankment were covered with a willow mattress and riprapped.

The full details of the five piers and caissons are given on Plates 5, 6 and 7. The rate of progress is illustrated graphically on Plate 8. Full records of the progress in detail of sinking these foundations are given in Appendix D.

The concrete used was manufactured in a mixer consisting of a nine inch spiral conveyor with teeth arranged between the flights and running in a wrought iron trough. The sand, cement and water were mixed in this mixer and the stone was put in after depositing the concrete in position. The whole was thoroughly rammed. Inside the working chamber no stone was used and the proportion of sand and cement varied from two to four parts of sand to one of cement.

The abutment at the east end of the bridge is a small piece of masonry of limestone; it is illustrated on Plate 5.

The dimension work of the five piers which are exposed to frost is of granite quarried at Morton, Minnesota, and the remainder of the work is of limestone from Mankato, Minnesota. The elevations at which the granite was begun are shown on the plans of the several piers.

The amount of masonry and concrete in the bridge is as follows:

	Masonry. Cubic Yards.	Concrete. Cubic Yards.	Total.
Pier I.	778.79	.....	778.79
Pier II.	1 791.48	1 915.44	3 706.92
Pier III.	1 749.27	1 879.35	3 628.62
Pier IV.	4 781.06	1 879.35	3 660.41
Pier V.	817.92	1 489.03	2 306.95
East Abutment,	71.69	18.37	90.06
Total Cubic Yards,	6 990.21	7 181.54	14 171.75

The specifications for masonry are given in Appendix C.

IV.

SUPERSTRUCTURE.

The superstructure consists of four through spans and one plate girder. Each through span is 400 feet long between centers of end pins, divided into 15 panels of 26 feet, 8 inches each, the trusses being 50 feet deep and placed 22 feet between centers. Expansion is provided on Piers I, III and V.

Except the web plates of the plate girder, the entire superstructure is of steel.

The east span (I–II) is of imported steel from Scotland; the other three spans are of American steel. The imported steel seemed to be a little more uniform in quality than the American, but was less uniform in finish and sections. The weight of the Scotch steel span is slightly in excess of that of the others.

The trusses are proportioned to carry a moving load of 3000 lbs. per lineal foot, but in calculating the effects of a moving load the portion of any strain in excess of that which would have been produced by a uniform load of equal amount was taken on a basis of 5000 lbs. per foot. The top lateral system is proportioned to resist a wind pressure of 300 lbs. per lineal foot, and the bottom lateral system 500 lbs. per lineal foot. The strains are given on Plate 16.

The floor system was designed for a uniform load of 6000 lbs. per lineal foot.

The compressive strain in the top chord is limited to 14000 lbs. per square inch of balanced section.

The tensile strain in the bottom chord is limited to 13000 lbs. per square inch and that in the web members is kept somewhat lower.

The weights of iron and steel in the through spans are as follows:

	SCOTCH SPAN	THREE AMERICAN SPANS	AVERAGE OF THREE SPANS
	Lbs.	Lbs.	Lbs.
Steel, . . .	1 085 572	3 244 103	1 081 368
Wrought Iron,	6 349	18 404	6 155
Cast Iron,	22 574	67 605	32 535
Total, .	1 114 795	3 330 172	1 110 057

The plate girder weighs 41 340 lbs. making the entire weight of the whole superstructure 4 485 807 lbs.

The specifications under which the superstructure was manufactured are given in Appendix F.

The days on which the several trusses were erected are shown in the following table:

	First Iron Placed	Span Swung
East Approach Girder,	Nov. 22, 1888	
Through Span, I – II,	Aug. 4, 1888.	Aug 9, 1888.
" " II – III,	Sept. 11, 1888	Sept. 17, 1888
" " III – IV,	Oct. 20, 1888	Oct 26, 1888
" " IV – V,	Nov. 13, 1888	Nov. 18, 1888.

The timber floor was put on by the company's men working under the direction of the Resident Engineer; the painting was done in the same way.

V.

APPROACHES.

THE east approach includes a bridge across the Floyd River consisting of three spans of plate girders, resting on two masonry abutments and two iron cylinder piers, all having pile foundations. It also includes a timber trestle 600 feet long near some of the packing houses. The remainder of the line is of earth work, it all being embankment except a large cut immediately east of the bridge.

The total amount of material in this approach is given in the following table:

Excavation hauled into embankments,	98 446	cubic yards.
Material borrowed for "	68 483	" "
Total	166 929	" "

The west approach comprises a timber trestle 1 840 feet long extending west from Pier V, beyond which it is all built as an earth embankment, the total amount of earth work in this approach being 66 832 cubic yards.

Both approaches are built with a maximum grade of 1.25 per cent. (66 ft. per mile).

The alignment and grades of the approaches are shown on Plate 2.

APPENDIX A.

LIST OF ENGINEERS, EMPLOYEES AND CONTRACTORS.

ENGINEERS AND COMPANY'S EMPLOYEES

NAME.	OCCUPATION	TIME OF SERVICE
George S. Morison,	Chief Engineer,	to April 30, 1887.
Morison & Cortheil,	" "	May 1, 1887 " April 30, 1889
George S. Morison.	"	May 1, 1889 " Completion.
E. Gerber,	Resident Engineer,	June 15, 1887 " Dec 31, 1888
A. B. Cortheil,	Assistant "	July 3, 1887 " April 4, 1888.
J. W. Fiege,	" "	April 15, 1886 " Aug. 8, 1887.
E. H. Mayne,	" "	June 24, 1887 " Sept 21, 1888
Andrew Thompson,	" "	Dec 10, 1887 " Dec 31 1888.
O. Gunkle,	Chief Clerk,	Aug 15, 1887 " May 1, 1888
C. H. Schaad,	"	May 1, 1888 " Mar. 11, 1889
Paul Wilas,	Insp. Superstructure at Shops,	Sep. 26, 1887 " Nov 2, 1888
R. W. Hildreth,	" " "	Dec. 26, 1887 " Nov. 7, 1888
R. Modiesk.,	" " "	Mar 20, 1888 " Sep 30 1888.
H. W. Parkhurst,	Inspector Stone at Quarries,	Nov 15, 1887 Jan 1, 1888.
Z. W. Craig,	" " "	Dec. 1, 1887 " June 30, 1888.
William Hill,	Inspector of Masonry,	July 5 1887 " Oct 31, 1888.
Dennis Brophy	Master Mechanic,	July 7, 1887 " Oct. 31, 1888
Dennis Leonard,	Foreman of Pressure Work,	Sept 8, 1887 " Oct. 15, 1888
William Wride,	Foreman of Carpenters,	Aug 23, 1887 " Jan 20, 1889

CONTRACTORS

NAME	NATURE OF WORK.
T. Sadlpaugh & Co.	Masonry
Chas Stears, Foreman of Masons.	
O. W. Davis, " " Stonecutters	
Union Bridge Co.	Superstructure
Baird Brothers,	Erection
Geo. Buchan, Superintendent	
McNamara & McCarty,	Earthwork.
Wakefield & Hill.	Trestlework

APPENDIX B.

ACT OF CONGRESS AUTHORIZING CONSTRUCTION OF SIOUX CITY BRIDGE.

An Act entitled "An Act to authorize the construction of a bridge across the Missouri River at or near Sioux City, Iowa."

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, that it shall be lawful for the Sioux City Bridge Company, a corporation organized for that purpose under the general corporation laws of the State of Iowa, or its assigns, to construct under and subject to the conditions and limitations hereafter provided, a bridge across the Missouri River at or near Sioux City, Iowa, and lay on and over said bridge railway tracks, for the more perfect connection of any and all railways that now are, or which may hereafter be, constructed to the Missouri River at or near Sioux City, or to the river on the opposite side of the same near Sioux City and build, erect, and lay on and over said bridge ways for wagons, vehicles of all kinds, and for the transit of animals, and to provide ways for foot passengers, and to keep up and maintain and operate said bridge for the purposes aforesaid; and that when said bridge is constructed all trains of all railroads terminating at said river and on the opposite side thereof, at or near Sioux City, Iowa, shall be allowed to cross said bridge for reasonable compensation, to be made to the owners of the same under the limitations and conditions hereinafter named. The owners of said bridge may also charge and receive reasonable compensation or tolls for the transit over said bridge of all wagons, carriages, vehicles, animals and foot passengers: *Provided*, That Congress may at any time prescribe such rules, regulations and rates of toll for transit and transportation over said bridge as may be deemed proper and reasonable.

SECTION 2. That any bridge built under the provisions of this Act may, at the option of the person or persons or corporation building the same, be built as a draw bridge, with a pivot or other form of draw, or with unbroken or continuous spans. *Provided*, That if the same shall be made of unbroken or continuous spans, it shall not be, in any case, of less elevation than fifty feet above extreme high-water mark, as understood at the point of location, to the lowest part of the superstructure, with straight girders, nor shall the spans of said bridge be less than three hundred feet in the clear at low-water mark; and the piers of said bridge shall be parallel with the current of the river; and the main span shall be over the main channel of the river. And provided also, that if a bridge shall be built under this Act as a draw bridge, the same shall be constructed as a pivot draw bridge, with a draw over the main channel of the river at an accessible and navigable point and with spans of not less than one hundred and sixty feet in length in the clear on each side of the central or pivot pier of the draw, and the next adjoining spans to the draw shall not be less than two hundred and fifty feet, and said spans shall not be less than ten feet above extreme high water mark, measuring to the lowest part of the superstructure of the bridge; and the piers of said bridge shall be parallel with the current of the river: *And provided also*, That said draw shall be opened promptly upon reasonable signal, without unnecessary delay: *And provided further*, That the corporation building said bridge may, subject to the approval of the Secretary of War, enter upon the banks of said river, either above or below the point of location of said bridge, and confine the flow of the water to a permanent channel, and to do whatever may be necessary to accomplish said object, but shall not impede or obstruct the navigation of said river, and shall be liable in damages for all injuries to private property; and all plans for such works or erections upon the banks of the river shall first be submitted to the Secretary of War for his approval: *And provided further*, That if said company shall elect to construct a pile or pontoon bridge in lieu of that described above, the Secretary of War may, if he deem it advisable and not inconsistent with the free navigation of said river, authorize said company to construct such bridge as a pile or pontoon bridge subject to the restrictions and requirements relating to the construction thereof contained in the Act entitled, "An Act to legalize and establish a pontoon bridge across the Mississippi River at Prairie du Chien," approved June sixth, eighteen hundred and seventy-four, except that in the bridge herein authorized one draw only shall be required, which shall not be less than four hundred feet in width in the clear: *And provided further*, That any bridge built under the provisions of this Act shall be at right angles to the current of the river.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall at any time substantially or materially obstruct the free navigation of said river; and no bridge shall be commenced or built under this Act until the location thereof and the plans and specifications for its construction shall have been submitted to, and approved by, the Secretary of War; and any change in the plan of such construction or any alteration in the bridge after its construction shall be subject to the like approval; and whenever such bridge shall, in the opinion of the Secretary of War, substantially obstruct the free navigation of said river, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and all such alterations shall be made, and all such obstructions be removed at the expense of the owner or owners of said bridge; and in case any litigation arising from any obstruction or alleged obstruction to the free navigation of Missouri River at or near the crossing of said bridge caused or alleged to be caused thereby, the cause shall be commenced and tried in the district courts of either judicial district in Iowa or Nebraska in which the said bridge or any portion of such obstruction touches

SEC. 4. That any bridge built under this Act and according to its limitations shall be a lawful structure, and shall be recognized and known as a postroute, upon which also no higher charges shall be made for the transportation over the same of the mails, the troops, and munitions of war of the United States than the rate per mile paid for their transportation over the railroads or public highways leading to such bridge.

Such lights shall be kept upon said bridge as the Light House Board shall direct, and said bridge shall moreover be provided with all proper safeguards for the security of person and property.

SEC. 5. That Congress may at any time alter, amend or repeal this Act.

Approved August 15, 1876.

CONTRACT WITH WAR DEPARTMENT.

WHEREAS, By an Act of Congress, approved August 15, 1876, entitled "An Act to authorize the construction of a bridge across the Missouri River at or near Sioux City, Iowa," it was enacted: "That it shall be lawful for the Sioux City Bridge Company, a corporation organized for that purpose under the general corporation laws of the State of Iowa, or its assigns, to construct under and subject to the conditions and limitations hereafter provided a bridge across the Missouri River, at or near Sioux City, Iowa;" and

WHEREAS, It was provided by Section 3, of the Act of Congress aforesaid, That "no bridge shall be commenced or built under this Act until the location thereof and the plans and specifications for its construction shall have been submitted to and approved by the Secretary of War; and any change in the plan of such construction or any alteration in the bridge after its construction shall be subject to the like approval;" and

WHEREAS, The Sioux City Bridge Company has accepted the provisions, conditions and limitations of the Act of Congress aforesaid, and in compliance therewith has submitted for the approval of the Secretary of War, a map of the location of said bridge, and plans and specifications for its construction; and

WHEREAS, Lieutenant Colonel Suter, Corps of Engineers United States Army, and President of the Missouri River Commission, reports, that "these plans have been examined by the Missouri River Commission and are considered by them to provide for an entirely satisfactory structure;" and

WHEREAS, The Chief of Engineers, United States Army, recommends that the plans submitted by the Sioux City Bridge Company be approved·

Now therefore, I, S. V. Benét, Acting Secretary of War, having examined the plans and specifications for the construction of said bridge, and the map of location, submitted by the Sioux City Bridge Company, do hereby approve the same.

Witness my hand this fourteenth day of June, 1887.

The words "William C. Endicott" having been erased and "S.V. Benét, Acting" substituted in the last paragraph before signing.

S. V. BENÉT,
Brig. Gen. Chief of Ordnance and Acting Secretary of War.

This instrument is also executed by the Sioux City Bridge Company by its President thereto lawfully authorized this tenth day of June, 1887, in testimony of its acceptance of the provisions, conditions and limitations of the Act of Congress aforesaid.

THE SIOUX CITY BRIDGE COMPANY, BY MARVIN HUGHITT,
[SEAL] *President.*

In presence of *Attest.*

CHAS. L. LOWE, J. B. REDFIELD,
C. G. KINGWILL. *Secretary.*

APPENDIX C.

SPECIFICATIONS FOR MASONRY.

The masonry will be first class rock face work, laid in regular courses.

The piers shall conform in all respects to the plans furnished by the engineer. The face stones, including coping above the elevations designated on the plans, shall be of granite from the quarries near Morton, Minnesota. All other stone shall be limestone from the quarries near Mankato, Minnesota.

The stone shall be cut and coursed out at the quarries, every dimension stone being marked, and full course plans being sent at time of shipment.

No course shall be less than 16 inches thick, and no course shall be thicker than the course below it.

The upper and the lower bed of every stone shall be at least one-quarter greater in both directions than the thickness of the course, and no face stone shall measure less than thirty inches in either horizontal direction.

In general, every third stone of each course shall be a header, and there shall be at least two headers on each side of each course between the shoulders. No stone will be considered a header that measures less than five feet back from the face. The headers shall be so arranged as to form a bond entirely through the pier, either by bonding against a face stone in the opposite side of the course or by bonding with a piece of backing not less than three feet square, which shall bond with a face stone on the opposite side. In all cases the interior bonding shall be further secured by placing in the course above a stone at least three feet square over the interior joints. Special care shall be taken with the bonding of the ice-breaker cut-water, the stones of which shall be so arranged that the face stones are supported from behind by large pieces of backing.

All joints shall be pitched to a true line, and dressed to one-quarter inch for at least twelve inches from the face. Beds, both upper and lower, shall be pitched to a true line and dressed to one-fourth inch. Joints shall be broken at least 15 inches on the face. The bottom bed shall always be the full size of the stone.

The face of the up-stream starling of Piers II, III and IV shall be fine pointed, with no projection exceeding one-half inch. There shall be a draft line three inches wide around the lower edge of the belting course below the coping, and on the edge of the down-stream starling of Piers II, III and IV. The coping over the whole pier, and the small coping over the pointed starlings of Piers II, III and IV shall have a smooth-cut surface and face. All other parts of the work shall have a rough quarry face with no projections exceeding three inches from the pitch line of the joints.

The stones for the coping under the bearings of the trusses shall be cut according to special plans to be furnished by the engineer. They shall have good beds for their entire sizes, and a full bearing on large stones with dressed beds in the belting course below the coping. The stones of the backing shall be of the same thickness as the face stones, and shall have dressed beds. All stones shall be sound, free from seams or other defects, and all limestone shall be laid with the natural beds horizontal

All stones shall be laid in full mortar beds. They shall be lowered on the bed of mortar and brought to a bearing with a maul. No spalls will be allowed except in small vertical openings in the backing. Thin mortar joints will not be insisted upon, but the joints shall be properly cleaned on the face and pointed in mild weather, the pointing to be driven in with a calking iron.

The face stones of each course in Piers II, III and IV for a height of 26 feet, beginning about three feet below low water, shall be doweled into those of the course below with round dowels of one and one-eighth inch iron, extending six inches into each course; the dowels shall be from 8 to 12 inches back from the face, and 6 inches on each side of every joint; the stones of the upper course shall be drilled through before setting, after which the drill-hole shall be extended six inches into the lower course; a small quantity of mortar shall then be put into the hole, the dowel dropped in and driven home, and the hole filled with mortar and rammed. The three courses below the coping shall have the joints bound with cramps of seven-eighths of an inch round iron, 20 inches long between shoulders, the ends sunk three inches into each stone.

The mortar will be composed of cement and clean coarse sand, satisfactory to the engineer, in proportions varying from one to three parts of sand to one of cement, as may be directed by the engineer for different parts of the work. When stone is laid in freezing weather, the contractor shall take such precautions to prevent the mortar's freezing as shall be satisfactory to the engineer.

No material shall be measured or included in the estimate, which does not form a part of the permanent structure.

All necessary tools and materials of every description whatsoever, except cement, will be furnished by the contractor. The cement will be furnished by the Bridge Company, the contractor taking the same from the storehouse.

The Bridge Company will pay for the transportation of the stone from the quarries to the bridge site; but any stone transported and left over from the work will be the property of the Bridge Company.

APPENDIX D.

RECORD OF SINKING CAISSONS.

PIER II.

READINGS TAKEN AT 8 A. M.

Date		Elevation of Cutting Edge N. E.	N. W.	S. W.	S. E.	Average	Sunk in 24 Hours, Feet	Elevation of Sand N. E.	N. W.	S. W.	S. E.	Average	Average Penetration of Caisson, Feet	Water Gauge	Depth Immersed, Feet	Elevation of Top of Pier
Nov	17	672.43	672.38	672.38	672.4	672.40		661.0	660.0	660.2	663.5	660.98		668.20		690.40
	18	667.79	667.8	667.77	667.78	667.79	4.61	661.2	659.6	660.3	663.3	660.88		668.30	0.51	685.79
	19	667.79	667.81	667.77	667.78	667.79	0.00	660.6	659.3	660.5	662.5	660.52		668.30	0.51	685.79
	20	662.00	662.07	661.95	661.76	661.94	5.85	660.0	659.0	660.7	661.8	660.17		668.08	6.14	679.54
	21	661.07	661.34	660.89	660.76	661.01	0.93	657.8	657.6	660.9	662.4	660.46		668.25	7.24	679.01
	22	659.63	660.42	660.49	659.76	660.08	0.93	659.0	658.7	665.9	662.6	661.23	1.15	668.18	8.10	678.08
	23	657.95	656.85	656.81	656.63	657.06	3.02	658.7	657.5	666.9	662.8	661.87	4.81	668.16	11.10	675.06
	24	653.74	654.43	652.66	652.05	653.22	3.84	658.4	661.3	663.8	665.3	663.61	10.39	667.85	14.63	671.22
	25	649.74	649.98	649.87	649.68	649.82	3.40	661.4	665.6	664.4	667.9	665.23	15.41	667.88	18.06	671.82
	26	647.21	647.19	647.62	647.70	647.43	2.39	662	667.6	665.8	667.6	666.09	18.66	667.04	19.61	673.43
	27	646.28	646.01	645.95	646.11	646.09	1.34	663.5	665.1	665.8	667.6	666.11	20.02	665.13	19.04	673.09
	28	645.69	645.96	645.67	645.70	645.76	0.33	663.8	666.4	665.8	666.8	666.07	20.31	666.80	21.04	672.70
	29	645.34	645.64	645.19	644.98	645.29	0.47	667.3	663.8	665.[illegible]	666.0	665.66	20.37	667.32	22.03	674.29
	30	645.31	645.56	645.15	644.96	645.24	0.05	666.9	665.[illegible]	665.4	666.[illegible]	665.96	20.72	666.86	21.62	675.24
Dec	1	643.23	643.60	643.59	643.23	643.41	1.83	667.7	665	665.[illegible]	667.2	666.11	22.70	666.18	22.78	676.40
	2	637.12	637.21	637.60	637.59	637.38	6.03	665.0	666.4	667.6	666.8	666.02	29.64	666.34	28.96	673.76
	3	633.40	633.33	634.01	634.17	633.73	3.65	665.2	665.0	666.1	666.9	665.54	31.81	666.67	32.94	671.48
	4	628.44	628.34	629.12	629.28	628.79	4.94	666.8	668.2	667.5	668.0	667.80	39.01	666.79	38.00	670.79
	5	626.87	626.81	627.79	627.98	627.36	1.43	667.5	667.6	666.6	667.0	667.37	40.01	667.05	39.69	670.36
	6	625.36	625.35	625.81	625.89	625.60	1.76	667.6	668	667.8	668.4	668.20	42.60	666.58	40.98	670.60
	7	623.64	623.74	623.93	623.97	623.82	1.78	667.5	667.8	667.8	668.1	668.07	44.25	666.2[illegible]	42.3[illegible]	671.26
	8	623.10	623.20	623.28	623.30	623.22	0.60	667.2	667.5	667.6	668.[illegible]	667.80	44.58	666.39	43.47	670.66
	9	623.08	623.20	623.27	623.29	623.21	0.01	667.4	667.5	668.[illegible]	668.4	667.89	44.68	666.52	43.31	670.65
	10	623.10	623.19	623.2[illegible]	623.29	623.21	0.00	667.2	667.3	667.5	668.0	667.68	44.47	666.62	43.41	670.[illegible]
	11	623.03	623.07	623.22	623.22	623.12	0.09	667.2	667.3	667.5	668.0	667.68	44.56	667.01	43.89	670.56
	12	622.91	623.02	623.03	623.03	623.00	0.12	667.2	667.3	667.5	668.0	667.68	44.68	667.28	44.28	672.53
	13	617.49	617.64	617.86	717.71	617.67	5.33	667.2	667.6	667.9	667.3	667.47	49.80	667.36	49.69	671.26
	14	615.07	615.13	615.35	615.28	615.21	2.46	664.8	667.5	667.5	665.[illegible]	666.38	51.17	667.50	52.27	673.3
	15	614.97	615.10	615.32	615.1[illegible]	615.14	0.07	666.7	667.8	667.5	666.5	667.03	52.79	667.76	52.62	675.35
	16	614.36	614.36	614.90	614.79	614.60	0.54	668.7	667.8	667.5	666.[illegible]	667.93	53.33	668.11	53.51	678.98
	17	613.[illegible]	613.00	613.70	613.58	613.32	1.28	669.9	667.1	667.1	666.7	667.18	53.86	668.05	54.73	677.80
	18	611.94	611.68	612.69	612.48	612.20	1.12	668.7	666.3	667.5	666.7	667.11	54.91	668.20	56.00	680.32
	19	610.08	610.69	611.50	611.50	611.09	1.11	667.6	665.6	667.9	666.7	667.03	55.94	668.27	57.18	679.21
	20	610.63	610.64	611.38	610.34	610.75	0.34	668.7	668.7	669.3	668.2	668.38	57.63	669.20	58.45	678.87
	21	608.57	608.57	609.53	609.53	609.05	1.70	669.4	663.[illegible]	669.[illegible]	666.6	667.46	58.4	669.90	60.85	677.17
	22	607.42	607.41	608.30	608.30	607.86	1.19	670.1	669.8	670.3	666.8	669.56	61.70	670.27	62.43	675.98
	23	606.44	605.99	606.95	606.83	606.55	1.31	670.8	669.1	670.7	669.[illegible]	670.18	63.63	670.02	63.47	674.67
	24	603.88	603.79	604.61	604.65	604.23	2.32	671.8	664.[illegible]	669.5	669.6	669.34	65.11	670.08	65.85	672.35
	25	602.36	602.25	603.28	603.47	602.83	1.40	668.5	663.6	669.4	668.4	668.19	65.36	670.05	67.22	670.95
	26	602.36	602.24	603.30	603.42	602.83	0.00	668.5	663.4	669.3	668.5	668.07	65.24	670.07	67.24	670.95
	27	602.36	602.25	603.28	603.42	602.83	0.00	668.5	663.4	669.3	668.5	668.07	65.24	670.20	67.37	670.95
	28	601.95	600.79	601.78	602.11	601.66	1.1[illegible]	668.5	669.1	671.8	670.3	670.01	68.35	670.55	68.89	671.58
	29	599.41	599.11	600.03	600.04	599.65	2.01	671.6	670.0	671.4	671.5	671.10	71.45	670.47	70.82	673.83
	30	597.15	596.89	597.56	597.68	597.33	2.32	669.5	668.5	671.3	668.4	669.61	72.28	670.49	73.16	675.77
	31	595.38	594.99	595.67	595.70	595.43	1.90	667.5	670.0	671.0	669.5	669.64	74.21	670.54	75.11	673.87
Jan.	1	593.10	593.12	593.23	593.4	593.29	2.14	665.5	670.9	671.5	668.2	669.1	75.82	670.69	77.40	671.73
	2	593.49	593.03	593.31	593.14	593.24	0.05	665.6	670.7	670.8	668.0	669.07	75.83	670.81	77.57	671.71
	3	591.74	591.50	591.43	591.57	591.56	1.68	665.0	669.7	670.7	671.1	669.09	77.53	670.87	79.31	674.11
	4	590.01	589.81	589.77	589.84	589.86	1.70	664.5	669	671.0	669.2	668.64	78.78	671.00	81.14	676.51
	5	590.00	589.73	589.73	589.90	589.84	0.02	666.0	671.3	672.2	672.1	670.00	80.[illegible]	671.06	81.22	680.59
	6	588.24	587.96	588.06	588.35	588.15	1.69	671.1	673	[illegible]	669.6	670.07	[illegible]	671.[illegible]	82.96	680.90
	7	586.55	586.34	586.44	586.58	586.48	1.67	669.3	670.7	671.5	671.3	670.51	84.03	671.22	84.74	680.73
	8	584.64	584.50	584.67	584.78	584.65	1.83	672.3	673.4	672.5	669.8	672.02	87.27	671.35	86.70	679.40
	9	584.61	584.44	584.68	584.73	584.61	0.04	667.4	669	670.9	671.4	670.71	86.15	671.4[illegible]	86.84	679.37
	10	582.68	582.58	582.86	582.90	582.75	1.86	675.5	671.8	672	671.5	670.46	[illegible]	671.53	88.78	677.51
	11	580.19	580.16	580.37	580.47	580.30	2.45	667.2	[illegible]	[illegible]	669.0	669.96	[illegible]	671.60	91.30	675.05
	12	580.14	580.09	580.33	580.38	580.23	0.07	667.3	672.3	672.2	67[illegible].0	670.14	90.11	671.54	91.31	674.98
	13	579.58	579.53	579.71	579.75	579.64	0.59					670.35	90.71	671.67	92.03	674.39
	14	579.54	579.38	579.65	579.58	579.54	0.10					670.25	90.71	671.66	92.12	674.29
	15	579.54	579.38	579.65	579.58	579.54	0.00					670.25	90.71	671.64	92.10	674.39
	16	579.57	579.36	579.63	579.56	579.53	0.01					670.24	90.71	671.55	92.07	674.38
	22	579.53	579.34	579.62	579.56	579.51	0.02									
	23	579.41	579.32	579.59	579.55	579.47	0.04									

Date		Weights, Tons: Caisson	Crib	Masonry	External Sand	Water	Total	Air Pressure, Pounds: Indicated	Calculated	Reaction due to Air Pressure, Tons	Net Weight, Tons	Surface in Contact, Square Feet	Average Wt. per Sq. Ft. of Surface Exposed to Friction, Lbs.	Material	Hours Worked by Sand Pump	Remarks
Nov	17	238			..		238				238			668 0		Caisson suspended by screws; began lowering at 10:15 A. M.; stopped at 4.20 P. M.
	18	238					238				238					No lowering done; waiting for concrete mixer.
	19	238			.		238				238			Water		Lowering commenced at 9.00 A. M.; concreting, at 1:00 P. M.
	20	268					268				268					Air pressure put on at 7:00 P. M.
	21	345	1		.		346		3.136	379	−33			663 0		Screws taken off at 2 00 P. M; caisson tilted to East.
	22	463	1				464		3.509	424	40	199	402			Sand pumps started at 2.30 P. M.
	23	718	2				720	2.50	4.808	581	139	834	333		7½	
	24	986	14		11		1011	5.50	6.338	766	245	1802	272		24	Four piles from wrecked bridge found in North chamber
	25	1039	258		30		1327	7.00	7.824	945	382	2672	286		24	Piles cut out during night.
	26	1039	544		44	5	1632	8.00	8.495	1026	606	3236	375		14	Stumps and four logs found; one oak. Stopped sand pumps at 10 00 A. M.; waiting for air-lock.
	27	1039	649		74		1762	8.00	8.248	996	766	3472	441			
	28	1039	649		79	4	1771	7.75	9.140	1101	670	3522	380	Fine Sand		
	29	1039	819		79	9	1946	9.25	9.543	1153	793	3533	449			
	30	1039	[illegible]		85	5	[illegible]	8.00	9.365	1132	978	3593	544			Sand pumps started at 4:30 P. M.
Dec	1	1039	1287		116		2442	9.00	9.868	1192	1250	3937	635		5½	
	2	1039	1412		229		2680	11.50	12.545	1516	1164	5140	453		24	
	3	1039	1668		267	6	2980	13.75	14.270	1724	1256	5516	455	632 0	24	
	4	1039	1844		390		3273	15.00	16.461	1989	1284	6766	380		24	
	5	1039	1948		409		3396	16.50	17.193	2077	1319	6938	380		15	Waiting for concrete.
	6	1039	2120		457		3616	16.00	17.752	2145	1471	7388	398		10	" " Concreting finished at 6 30 P. M.
	7	1039	2280		489		3808	17.00	18.363	2219	1589	7674	414		8	Sand pumps stopped at 7 00 A. M.; waiting for masonry
	8	1039	2280		496		3815	18.00	18.701	2259	1556	7731	403	Fine sand, with some few pebbles	..	Waiting for masonry
	9	1039	2280		497		3816	18.00	18.762	2267	1549	7748	400			" "
	10	1039	2280		493		3812	18.00	18.805	2272	1540	7712	399			" "
	11	1039	2280		495		3814	18.00	19.013	2297	1517	7738	393			" "
	12	1039	2280	154	502		3975	18.00	19.182	2318	1657	7748	428			" "
	13	1039	2280	319	645		4283	20.50	21.525	2601	1682	8636	390	61[illegible] 0	¼	" " Sand pumps started at 7 45 A. M.
	14	1039	2280	558	709	23	4609	22.50	22.652	2737	1872	8874	422		24	Found large body of clay in S. E. corner, and lumps over entire surface. Settled by blowing at 3.45 A. M.
	15	1039	2280	735	795		4849	22.00	22.795	2754	2095	9155	458		24	
	16	1039	2280	926	824	5	5074	23.25	23.181	2801	2273	9248	492		24	
	17	1039	2280	943	847	21	5137	23.00	23.709	2865	2267	9340	485		24	
	18	1039	2280	1125	909	26	5379	23.50	24.259	2931	2448	9522	514	[illegible]	24	
	19	1039	2280	1125	966	28	5438	24.00	24.770	2993	2445	9701	504		24	
	20	1039	2280	1125	1059	9	5522	24.00	25.321	3059	2463	9994	493		10½	Hoisted clay.
	21	1039	2280	1125	1102	56	5602	25.50	26.360	3185	2417	10129	477		24	
	22	1039	2280	1125	1186	6	5736	26.75	27.045	3268	2478	10700	463		24	
	23	1039	2280	1126	1395		5840	27.20	27.495	3322	2518	11035	456		18	Hoisted Clay.
	24	1039	2280	1126	1479	16	5940	27.60	28.526	3447	2493	11292	442	605 0	24	
	25	1039	2280	1126	1550	21	6016	28.50	29.120	3518	2498	11335	441		21½	Sand pumps stopped at 5:30 A. M., waiting for masonry.
	26	1039	2280	1126	1543	23	6011	28.75	29.128	3519	2492	11314	441	[illegible]		
	27	1039	2280	1126	1543	26	6014	29.50	29.185	3526	2488	11314	440			Sand pumps started at 6 00 P. M.
	28	1039	2280	1236	1679	12	6236	29.50	29.843	3606	2630	11853	444		14	Hoisting gravel; sand pumps stopped at 1[illegible] 00 A. M., for masonry.
	29	1039	2280	1382	1845		6546	30.25	30.679	3707	2839	12381	459		24	
	30	1039	2280	1538	1894	2	6772	31.10	31.693	3829	2943	12537	470		24	
	31	1039	2280	1538	2007	21	6885	32.00	32.537	3931	2954	12870	459	596 5	24	
Jan.	1	1039	2280	1605	2103	37	7064	33.00	33.576	4051	3013	13148	458		14	Hoisting gravel, sand pumps stopped at 11 00 A. M., for masonry
	2	1039	2280	1605	2107	40	7066	33.00	33.602	4060	3006	13150	457		3	Sand pumps started at 9 00 A. M.
	3	1039	2280	1803	2205	42	7369	34.00	34.357	4151	3218	13445	479		24	
	4	1039	2280	1963	2280	56	7618	34.50	35.149	4247	3371	13667	493		17	Hoisting gravel
	5	1039	2280	2109	2364	25	7817	34.75	35.184	4251	3566	13901	513	Coarse gray sand with less gravel and boulders but the latter larger	18	No work between 1.00 and 7 00 A. M. for want of pressure men. Pressure reduced five pounds in settling
	6	1039	2280	2132	2508	9	7968	35.0	35.738	4342	3626	14311	507		8	
	7	1039	2280	2268	2600	16	8203	35.50	36.709	4435	3768	14573	517		18	
	8	1039	2280	2268	2801		8388	36.50	37.558	4538	3850	15134	509		8	
	9	1039	2280	2268	2731	16	8334	37.00	37.619	4545	3789	14940	507		8	
	10	1039	2280	2268	2828	26	8441	37.50	38.459	4647	3794	15211	499		18	
	11	1039	2280	2268	2946	40	8573	38.25	39.551	4779	3794	15538	488		18	
	12	1039	2280	2268	3017	14	8618	38.75	39.555	4779	3839	15731	488		16	Repairs to pumps
	13	1039	2280	2268	3017	33	8637	39.75	39.667	4817	3820	15731	486		18	
	14	1039	2280	2268	3017	33	8637	39.75	39.906	4821	3816	15731	485		3	Sand pumps stopped at 10 00 A. M. 13th; full depth reached.
	15	1039	2280	2268	3017	33	8637	39.75	39.898	4820	3817	15731	485			Concreting working chamber
	16	1039	2280	2268	3017	30	8634	39.75	39.863	4816	3818	15731	485			" " "
	22															Working chamber filled. Air pressure stopped at 6 00 P. M.
	23															Taking out shafts.
															Total number of hours pumped.. 772¼	Average distance sunk per hour's pumping, $\frac{1044}{10000}$ feet.

APPENDIX D.—Continued.

RECORD OF SINKING CAISSONS.

PIER III.

READINGS TAKEN AT 8 A. M.

Date	Elevation of Cutting Edge. N. E.	N. W.	S. W.	S. E.	Average	Sunk in 24 Hours, Feet	Elevation of Sand. N. E.	N. W.	S. W.	S. E.	Average	Average Penetration of Caisson, Feet
Jan. 30	6?3.83	673.85	673.84	673.83	673.84							
31	670.83	670.82	670.81	670.83	670.82	3.02						
Feb. 1	666.50	666.48	666.37	666.58	666.48	4.34	666.4	667.4	667.1	667.9	667.16	0.70
2	666.00	666.41	666.28	666.40	666.27	0.2?	666.8	667.4	667.0	667.8	667.13	0.86
3	664.75	664.19	663.71	663.53	664.04	2.23	669.9	670.5	67?.1	671.5	671.00	6.9?
4	658.49	658.77	658.83	658.52	658.65	5.39	[illegible]	671.4	67?.8	671.6	672.05	13.40
5	654.34	654.30	654.15	654.16	654.24	4.41	673.3	672.6	673.9	672.7	673.16	8.97
6	653.09	652.93	653.00	653.11	653.03	1.21	[illegible]	672.5	[illegible]	[illegible]	672.06	9.03
7	648.84	648.77	648.99	648.8?	648.90	4.13	673.3	672.7	[illegible]	[illegible]	672.70	23.80
8	644.49	644.48	644.29	644.26	644.38	4.52	673.0	673.8	673.0	673.1	673.18	28.80
9	641.80	641.77	641.64	641.61	641.70	2.68	673.7	674.7	674.4	[illegible]	674.58	3?.88
10	637.81	637.92	637.51	637.39	637.66	4.04	67?.?	673.?	673.2	674	673.85	36.1?
11	635.52	635.58	634.76	634.73	635.1?	2.5?	672.6	67?.9	673.2	673.6	673.05	37.90
12	633.31	633.20	63?.61	632.7?	632.96	2.1?	672.5	673.?	672.5	[illegible]	673.46	40.47
13	628.7?	628.39	628.17	628.5?	628.48	4.5?	670.?	671.8	672.0	672.4	671.68	43.20
14	627.05	626.67	626.6?	62?.?0	626.88	1.60	674.4	675.6	674.6	674.5	674.78	47.90
15	627.0?	626.67	626.69	627.09	626.88	0.00	673.3	674.2	673.?	674.5	673.78	46.90
16	62?.8?	624.51	624.49	624.92	624.70	?.18	671.?	673.3	673.?	671.8	672.45	47.7?
17	622.??	622.41	622.45	[illegible]	622.5?	2.11	671.0	672.6	671.6	671.1	671.55	48.?6
18	622.?1	622.40	622.44	[illegible]	622.5?	0.01	671.0	673.7	673.3	670.8	672.18	49.60
19	620.?9	620.66	620.65	620.90	620.77	1.81	666.8	673.3	[illegible]	67?.8	671.67	50.90
20	61?.13	618.96	618.95	619.12	619.04	1.73	670.5	673.6	673.7	67?.2	672.24	53.?0
21	616.52	616.41	616.36	616.48	616.44	2.60	66?.7	673.?	673.7	670.1	671.34	54.90
22	612.25	612.15	612.13	612.14	612.??	4.??	671.8	672.4	672.3	67?.1	672.17	59.65
23	610.3?	610.25	610.21	610.22	610.25	[illegible]	673.5	672.8	672.6	67?.7	672.65	62.40
24	605.98	[illegible]	605.74	605.74	605.85	4.40	672.1	673.3	67?.9	671.?	672.65	66.80
25	603.83	603.8?	603.50	603.50	603.66	[illegible]	674.2	674.1	673.6	673.?	673.71	70.05
26	603.?3	603.8?	603.50	603.50	603.66	0.00	674.2	674.1	673.6	673.7	673.71	70.05
27	601.50	601.47	601.13	60?.?6	60?.32	2.34	673.0	674.0	674.1	67?.7	673.47	72.1?
28	599.72	599.60	599.26	599.31	599.49	1.83	673.0	674.5	674.5	674.0	673.99	74.50
29	597.81	597.73	597.35	597.43	597.58	1.91	672.3	673.9	673.5	673.9	672.66	75.05
Mar. 1	596.30	59?.20	595.83	595.92	596.06	1.52	672.4	674.8	67?.3	67?.4	673.?6	77.90
2	594.64	594.54	594.1?	594.29	594.41	1.65	672.5	673.7	674.0	673.8	673.46	79.05
3	591.4?	591.30	591.3?	591.53	591.42	2.99	670.4	673.?	673.2	671.5	672.17	80.75
4	591.4?	591.30	591.3?	591.33	591.42	0.00	670.4	673.5	673.3	671.5	672.17	80.75
5	58?.?0	589.90	589.35	589.74	589.6?	1.80	666.2	67?.4	673.0	670.2	670.37	[illegible]
6	588.4?	588.3?	588.25	588.40	588.36	[illegible]	666	673.6	673.4	671.4	67?.58	83.22
7	587.14	587.01	586.98	587.10	587.06	.30	667.?	[illegible]	[illegible]	[illegible]	670.??	83.40
8	587.14	587.01	586.97	587.09	587.05	0.01	670.1	673.6	674.3	674.8	673.?0	8?.1?
9	586.00	585.87	585.81	585.93	585.90	[illegible]	667.?	673.9	673.?	669.4	671.10	85.20
10	585.99	585.87	585.82	585.94	585.90	.00	671.1	674.2	673.?	673.?	673.10	87.20
11	584.97	584.90	584.86	584.96	584.93	0.97	669.7	[illegible]	[illegible]	673.4	672.05	87.?
12	583.37	583.33	583.35	583.38	583.36	1.57	[illegible]	672	67?	670.4	670.76	87.40
13	583.37	583.33	583.35	583.38	583.36	0.00	[illegible]	673.?	[illegible]	[illegible]	671.56	88.20
14	582.06	582.00	581.99	582.05	582.02	1.34	666.?	[illegible]	671.?	67?.3	671.32	89.30
15	582.06	582.00	581.99	582.05	582.02	0.00	666.1	673.1	671.9	6?3.3	671.32	89.30
16	581.11	581.05	581.04	581.09	581.07	[illegible]	667.0	67?.3	673.0	673.?	671.37	90.30
17	581.11	581.05	581.04	581.09	581.07	0.00						
18	581.11	581.05	581.04	581.09	581.07	0.00						
Ap. 24	58?.07	580.98	580.88	580.94	580.96	0.1?						
2?												
30												
May 7	581.02	580.97	580.88	580.93	580.95	0.0?						

Date	Water [illegible]	Depth Immersed, Feet	Elevation of Top of Pier	Weights, Tons. Caisson	Crib	Masonry	External Sand	Water	Total	Air Pressure, Pounds. In C[illegible]	[illegible]	Reduction due to Air Pressure, Tons	Net Weight, Tons	[illegible] Square Feet	Av. Wt. per Sq. Ft. [illegible] Expressed in Pounds	Material	Hours Worked by Sand Pump	Remarks
Jan. 30	670.10			338					[illegible]				[illegible]					Caisson suspended by screws. Commenced lowering at 5.00 P. M.
31	670.10			334					334				334					Screws taken off at ?.30 P. M. Caisson twisted. Stopped concreting at [8.00 P. M.
Feb. 1	670.08	3.60	67?.3	4?2					4?2				4??	[illegible]	8.32			Sand pump started at 11.00 A. M.
2	670.08	3.8?	676.0	63?					63?	2.00	650	[illegible]	4?3	4??	5??5		2?	
3	670.20	6.?	677.5	877			3		880	3.00	?660	3??	55?	[illegible]	?5		24	
4	670.32	1?.67	674.9	1039	1??		?1		1?78	5.00	5 55	6?1	56?	3324	4??		23½	
5	670.38	16.4	673.?	1039	364		45		1448	6.25	6.992	845	603	3281	368		1	Sand pump stopped on account of concrete, and putting on air-lock.
6	670.50	17.47	675.?	1039	6??		46		1757	[illegible]	7 568	914	843	3300	[illegible]		[illegible]	
7	67?.50	?.60	67?.?	1039	1000		35		2174	9.00	9 357	1130	1044	4128	306		24	
8	670.40	26.02	67?.?	1039	1???		[illegible]		2587	10.50	11.272	1362	1225	[illegible]	4?0		24	
9	670.35	28.65	676.2	1039	1?0?		300		2942	12.00	12 411	1500	1442	5702	30?		20½	Sand pump stopped, waiting for concrete.
10	670.87	33.21	67?.7	1039	1??4		367		3?30	13.50	14 386	1738	1492	6?76	4??	637.0	[illegible]	
11	[illegible]	3?.3?	676	1039	?13		4?3		3555	14.50	16 197	1957	[illegible]	[illegible]	4?6		?3	
12	6?2.07	3?.03	67?.9	1039	[illegible]		460		3849	16.50	16.907	2043	1?06	[illegible]	515		?4	
13	671.02	42.34	676.8	1039	?35?		?31		3?0	17.50	[illegible]	[illegible]	1684	[illegible]	4??	63?.0	?4	
14	672.71	45.83	675.3	1039	2350		634		4023	1?.00	[illegible]	[illegible]	[illegible]	?307	3??		?4	
15	672.78	45.90	675.?	1039	2350		60?		3998	19.00	1?.883	?40?	[illegible]	8134	[illegible]		?4	
16	67?.63	47.93	674.?	1039	2350	??	?3?	3	4184	20.00	[illegible]	[illegible]	[illegible]	?281	405		24	
17	672.47	4?.88	677.5	1039	2350	3?5	[illegible]	1?	4440	20.50	?.606	[illegible]	[illegible]	[illegible]	431		24	
18	67?.?3	4?.55	680	1039	2350	55?	[illegible]		4639	21.25	?1.465	2593	2046	8602	476		24	
19	672.23	51.4?	683.?	1039	2350	?44	?23	13	4869	22.00	[illegible]	2693	2176	[illegible]	4?3		2?	
20	672.42	53.38	68?	1039	2350	?44	?7?	?	50??	?.50	23 123	2794	2223	[illegible]	4??		24	
21	672.42	55.?8	67?.6	1039	2350	?44	?4?	?	51??	?3.50	24 250	2930	2177	[illegible]	45		24	
22	672.40	60.18	67?.3	1039	2350	?44	241		?381	?6.00	26 070	3158	2227	[illegible]	4??		2?	Sand pump stopped, waiting for masonry
23	672.37	62.?2	67?.7	1039	2350	?10	37?		5674	?.00	26.910	3251	2423	10???	448		1?	" " " " "
24	672.25	6?.40	67?.7	1039	2350	120	6??		?3?	?.?5	28.764	3475	2659	[illegible]	4??	5?.0	?	" " " " "
25	67?.46	?8.80	676.?	1039	2350	32?	181?		?330	[illegible]	[illegible]	3001	[illegible]	121??	4??			" " " " "
26	67?.6	68.9?	676.7	1039	2350	13??	8?		?330	31.00	29 869	3609	2921	[illegible]	4?1		4	" " " " "
27	672.61	[illegible]	678.4	1039	2350	14??	??		?3	31.00	30 882	3731	3062	[illegible]	4??		?4	
28	674.07	7?.?8	678.7	1039	2350	1603	?0 3	2	?06	3?.50	32 308	3904	3163	1??20	4?0		?4	
29	673.46	7?.88	681.0	1039	2350	1770	?06		[illegible]	3?.??	32.871	3971	3313	1?0?0	50?		?4	
Mar. 1	672.48	?6.4?	681.?	1039	2350	1888	?3?		[illegible]	33.5?	33.105	4000	3551	135?0	5??		?4	
2	672.46	78.05	68?.5	1039	2350	1956	?35?		?04	33.50	[illegible]	40??	[illegible]	13?1?	528	595.0	24	
3	67?.2?	81.86	67?.9	1039	2350	1???	?4??	2?	7817	34.50	35 461	4284	3533	14004	?5		?4	
4	672.47	8?.05	681.0	1039	2350	?00?	2446	?	?4?	35.00	35.111	4242	3607	1400?	?5		8?	Time shortened.
5	672.93	83.31	67?.1	1039	2350	?007	2446	61	?903	3?.00	36 090	4360	3543	14004	?0?		2?	
6	672.76	84.40	6??.6	1039	2350	?133	2596	?3	[illegible]	3?.??	36.561	4417	372?	1443?	[illegible]		21	
7	672.86	85.80	68?.6	1039	2350	?704	2?08	?6	?5?	3?.??	37 168	4491	3766	14464	?21		2?	
8	672.86	85.81	684.7	1039	2350	?5?	2??		?52?	3?.00	37 171	4491	4033	14941	?40		21	
9	[illegible]	87.00	68?.?	1039	2350	?3?1	2718	?	8530	3?.50	37.688	4554	3976	14776	53?		12	
10	673.00	87.10	683.5	1039	2350	23??	2842		8?12	3?.50	37 731	4559	4053	15122	53?		21	
11	672.86	87.?3	68?.0	1039	2350	2402	2?42	?6	[illegible]	3?.50	38 091	4602	4107	[illegible]	5?4		21	
12	672.86	8?.?0	683.0	1039	2350	2402	3???	??	[illegible]	3?.50	38.771	4684	4071	15157	53?		2	
13	672.75	8?.3?	683.0	1039	2350	2510	[illegible]	?8	?831	3?.50	38 723	4678	4153	[illegible]	54?		1?½	
14	672.65	90.?3	683.?	1039	2350	2510	??73	30	[illegible]	3?.50	39.261	4743	4159	154??	53?		1?	
15	672.80	[illegible]	683.0	1039	2350	2510	?73	35	[illegible]	3?.00	39.326	4751	4156	15487	537		1?	
16	673.10	?.03	682.6	1039	2350	2?0	3035	40	[illegible]	3?.00	39 867	4817	4157	[illegible]	53?		9?	Sand pump stopped at 4.30 P. M. Commenced concreting at 5:00 P. M.
17																		Concreting.
18																		At 2.00 P. M. air was taken off, and pier abandoned on account of high water.
Ap. 24																		Air put on, and preparation made to complete concreting.
2?																		Pressure-men struck, only twelve remaining. Commenced concreting.
30																		Forty five pressure-men at work.
May 7																		Concreting finished, and air taken off at 6:00 P. M.
	Total number of hours pumped............																871	Average distance sunk per hour's pumping, $\frac{88}{1000}$ feet.

APPENDIX D.—CONTINUED.

RECORD OF SINKING CAISSONS.

PIER IV.

READINGS TAKEN AT 8 A. M.

Date	Elevation of Cutting Edge N. E.	N. W.	S. W.	S. E.	Average	Sink in 24 Hours Feet
Aug. 21	[illegible]	675 45	675 44	[illegible]	[illegible]	
22	669 65	[illegible]	[illegible]	669 61	669 64	5 81
23	665 90	665.89	665.94	[illegible]	[illegible]	3.78
24	[illegible]	664 85	[illegible]	[illegible]	664.59	1 27
25	[illegible]	660 75	660 84	[illegible]	[illegible]	3.98
26	[illegible]	658 54	658.62	[illegible]	658.48	[illegible]
27	[illegible]	[illegible]	655 90	[illegible]	655.52	[illegible]
28	[illegible]	[illegible]	653.72	653 70	653.54	[illegible]
29	[illegible]	649.77	[illegible]	650.59	650 19	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	645.98	4 21
31	641 48	641 54	[illegible]	[illegible]	[illegible]	4 44
Sept. 1	[illegible]	637.13	[illegible]	636.87	636.99	[illegible]
2	[illegible]	[illegible]	[illegible]	634.42	634.35	[illegible]
3	[illegible]	631.99	[illegible]	[illegible]	[illegible]	2.38
4	629.69	[illegible]	[illegible]	629 63	[illegible]	2 06
5	[illegible]	[illegible]	[illegible]	629.64	629.91	0 00
6	627 31	627.57	[illegible]	627 24	[illegible]	2.52
7	627.32	627.57	627.46	627.23	[illegible]	0 00
8	625.03	625.03	[illegible]	[illegible]	[illegible]	[illegible]
9	624.75	624 75	624 87	624 89	[illegible]	[illegible]
10	[illegible]	623.06	[illegible]	[illegible]	[illegible]	[illegible]
11	621.21	[illegible]	621 15	[illegible]	[illegible]	[illegible]
12	[illegible]	619.24	619.05	618 94	[illegible]	[illegible]
13	616 26	616.40	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	611.04	[illegible]	611.32	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	606 03	606.04	[illegible]	[illegible]	606.04	4.82
17	606 01	[illegible]	606 07	[illegible]	[illegible]	0 00
18	604.24	604 27	[illegible]	[illegible]	604 27	[illegible]
19	[illegible]	599.73	[illegible]	[illegible]	599 79	[illegible]
20	597.05	597 01	597.16	[illegible]	597.10	[illegible]
21	[illegible]	[illegible]	597 16	[illegible]	597.09	[illegible]
22	594 80	[illegible]	[illegible]	594.96	594.86	[illegible]
23	[illegible]	[illegible]	593 38	593.41	593.31	[illegible]
24	591.67	[illegible]	591.79	[illegible]	591.73	1 58
25	591 67	591.68	[illegible]	591.78	[illegible]	0 01
26	[illegible]	[illegible]	590 22	[illegible]	590 16	1 56
27	[illegible]	[illegible]	588.80	[illegible]	588.81	1 35
28	[illegible]	[illegible]	[illegible]	586 79	[illegible]	1 99
29	[illegible]	584 81	[illegible]	[illegible]	[illegible]	2.04
30	582 79	582 78	[illegible]	[illegible]	582.76	[illegible]
Oct. 1	581.07	[illegible]	580.98	[illegible]	581.02	1 74
2	[illegible]	[illegible]	[illegible]	580 50	[illegible]	[illegible]
3	580 53	580 55	[illegible]	[illegible]	[illegible]	0 00
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0 02
10	580 51	[illegible]	580 40	580 47	580 48	[illegible]

Date	Elevation of Sand N. E.	N. W.	S. W.	S. E.	Average	Average Penetration Feet	Water Gauge	Depth Immersed Feet	Elevation of Top of Pier
Aug. 21							671 51		[illegible]
22							671 60	1 96	687 6
23	666 7	667.0	667 2	666 8	666.98	[illegible]	671 40	5 54	683.9
24	[illegible]	[illegible]	669.1	[illegible]	[illegible]	3 83	671 00	6.41	682.6
25	[illegible]	670.7	[illegible]	[illegible]	669 05	8 44	670.75	10.14	[illegible]
26	669 6	[illegible]	669.4	669 6	[illegible]	11 77	[illegible]	11 97	679 0
27	[illegible]	[illegible]	[illegible]	[illegible]	670.40	14.88	670.40	[illegible]	[illegible]
28	670 4	670.4	[illegible]	[illegible]	[illegible]	16 86	[illegible]	16 86	[illegible]
29	670 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	670 40	20 21	676 6
30	670.6	[illegible]	[illegible]	[illegible]	[illegible]	24 10	[illegible]	[illegible]	[illegible]
31	670 0	669 2	672 7	670.7	[illegible]	28 61	670 60	[illegible]	[illegible]
Sept. 1	671.5	671.5	[illegible]	[illegible]	[illegible]	34 41	[illegible]	33 51	[illegible]
2	669 4	669 4	[illegible]	[illegible]	[illegible]	[illegible]	670 40	[illegible]	[illegible]
3	669.6	669.3	[illegible]	670 3	[illegible]	37 65	[illegible]	38 33	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	669.42	[illegible]	670 10	[illegible]	676.8
5	[illegible]	666.4	[illegible]	671.2	[illegible]	[illegible]	670 00	[illegible]	676 8
6	669.8	666 0	667 5	[illegible]	[illegible]	40.56	669.85	[illegible]	[illegible]
7	[illegible]	[illegible]	667 6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	676.4
8	[illegible]	[illegible]	667.3	670 0	669.12	[illegible]	[illegible]	44 34	[illegible]
9	[illegible]	[illegible]	665 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible]	666.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]	667 50	46.32	669 10	47.92	674 9
12	[illegible]	[illegible]	666 2	[illegible]	668 85	49.77	668.90	[illegible]	[illegible]
13	669.0	668 6	[illegible]	667.1	667.70	[illegible]	668 80	[illegible]	[illegible]
14	[illegible]	665.7	664 3	664 3	665 00	[illegible]	[illegible]	57 63	674.0
15	[illegible]	665.7	664 0	664 0	[illegible]	[illegible]	668 50	57.64	676 2
16	[illegible]	662 6	[illegible]	662.6	[illegible]	56 61	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	664 1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	662 5	[illegible]	[illegible]	663.12	58.85	668.50	[illegible]	678 0
19	[illegible]	[illegible]	[illegible]	662 7	[illegible]	[illegible]	[illegible]	[illegible]	674 5
20	[illegible]	[illegible]	662.8	664.1	[illegible]	[illegible]	[illegible]	71.20	675 0
21	663.0	669 0	[illegible]	662 7	665 92	[illegible]	[illegible]	71 91	[illegible]
22	[illegible]	[illegible]	669 2	663.2	[illegible]	71 34	669.25	74 39	676 7
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71.66	[illegible]	[illegible]	[illegible]
24	[illegible]	669 7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	661.4	[illegible]	[illegible]	[illegible]	665 47	73 75	[illegible]	77 48	677 4
26	[illegible]	[illegible]	[illegible]	[illegible]	665 37	75 21	668 90	[illegible]	676 2
27	[illegible]	665.6	666.1	668 6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	668 6	666.72	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	666 3	[illegible]	80 39	668.77	83 99	[illegible]
30	[illegible]	662 7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	86.00	[illegible]
Oct. 1	[illegible]	[illegible]	[illegible]	[illegible]	666 60	[illegible]	669 00	87.98	675.2
2	[illegible]	669.1	[illegible]	[illegible]	669 12	[illegible]	[illegible]	88.51	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	669.3	669.1	666 8	669 3	669 12	88.64	667.98	87 50	674 6

Date	Weights, Tons: Caisson	Crib.	Masonry	External Sand	Water	Total	Air Pressure, Pounds: Indicated	Calculated
Aug. 21	[illegible]					[illegible]		
22	406					[illegible]		
23	674					674	3 00	[illegible]
24	[illegible]					920	3 00	2 777
25	1039	143		8		1190	4.50	4 393
26	1039	[illegible]		13		[illegible]	5 00	[illegible]
27	1039	559		[illegible]		1626	6.00	[illegible]
28	[illegible]	867		[illegible]		[illegible]	7 00	7 304
29	[illegible]	1132		[illegible]	2	[illegible]	8 50	8.754
30	[illegible]	[illegible]		140	3	[illegible]	10 50	10 665
31	[illegible]	1714		[illegible]	2	2976	12 00	12.588
Sept. 1	1039	2011		[illegible]		[illegible]	14 00	[illegible]
2	[illegible]	[illegible]		344	5	[illegible]	15 50	[illegible]
3	[illegible]	[illegible]		398	4	3721	16.50	[illegible]
4	1039	2280		440	[illegible]	[illegible]	18 00	[illegible]
5	[illegible]	[illegible]		[illegible]	4	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]		[illegible]	10	[illegible]	18 50	[illegible]
7	[illegible]	[illegible]	74	476	5	[illegible]	18.50	[illegible]
8	1039	[illegible]	[illegible]	[illegible]	[illegible]	4112	19 00	19 208
9	1039	[illegible]	423	514	[illegible]	[illegible]	[illegible]	[illegible]
10	1039	2280	423	547	10	[illegible]	20 75	[illegible]
11	1039	[illegible]	[illegible]	595	8	[illegible]	[illegible]	[illegible]
12	1039	2280	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
13	[illegible]	2280	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	1039	[illegible]	[illegible]	[illegible]	[illegible]	5251	24 00	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	87	[illegible]	[illegible]	[illegible]
16	[illegible]	2280	1230	1088	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	1088	134	5771	28 00	[illegible]
18	1039	2280	[illegible]	[illegible]	126	6068	28 50	[illegible]
19	[illegible]	2280	1610	[illegible]	[illegible]	[illegible]	30 00	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	106	[illegible]	[illegible]	[illegible]
21	[illegible]	2280	[illegible]	1760	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	1880	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	93	7274	[illegible]	[illegible]
24	1039	2280	[illegible]	[illegible]	98	[illegible]	33 00	[illegible]
25	[illegible]	[illegible]	1966	[illegible]	86	7426	[illegible]	[illegible]
26	1039	[illegible]	1966	2135	[illegible]	7502	34 00	34 110
27	[illegible]	[illegible]	[illegible]	2221	[illegible]	[illegible]	34 75	[illegible]
28	[illegible]	2280	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	2268	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oct. 1	[illegible]	[illegible]	[illegible]	2773	56	[illegible]	37.50	38.112
2	1039	2280	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
3	1039	[illegible]	[illegible]	[illegible]		[illegible]	37.50	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	38 00	[illegible]
10	1039	2280	2268	2962		8549	38 00	37 905

Date	Reduction due to Air Pressure Tons	Net Weight Tons	Surface in Contact Square Feet	Ave. Wt. per Sq. Ft. of Surface Exposed to Friction Lbs.	Material	Hours Worked by Sand Pump	Remarks
Aug. 21		[illegible]					
22		[illegible]					
23	[illegible]	[illegible]	94	[illegible]	Fine	6½	Air put on at 7 50 A. M. Screws taken off Sand pump started at 7 00 P. M.
24	335	[illegible]	664	[illegible]	Sand	20	
25	531	659	[illegible]	[illegible]		[illegible]	Pressure men concreting during the day. Pumping nights only
26	626	786	1954	[illegible]		8	" " " " " " "
27	[illegible]	847	2580	[illegible]		[illegible]	" " " " " " "
28	882	1058	[illegible]	[illegible]		[illegible]	
29	[illegible]	1188	[illegible]	688	648 0	[illegible]	
30	[illegible]	[illegible]	[illegible]	[illegible]	Fine sand	[illegible]	
31	[illegible]	[illegible]	[illegible]	[illegible]	with	[illegible]	
Sept. 1	[illegible]	[illegible]	[illegible]	[illegible]	pebbles	[illegible]	
2	[illegible]	[illegible]	[illegible]	542	637.0	[illegible]	
3	[illegible]	[illegible]	6528	[illegible]	[illegible] gravel [illegible]	[illegible]	
4	[illegible]	1660	6852	[illegible]		14	Repairs to pump.
5	2098	1660	6814	487	630 0	[illegible]	
6	[illegible]	[illegible]	7033	[illegible]	[illegible]	[illegible]	
7	[illegible]	1662	[illegible]	[illegible]	[illegible]	[illegible]	
8	2321	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
9	2331	[illegible]	[illegible]	[illegible]	[illegible]	24	
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
11	[illegible]	[illegible]	8032	[illegible]	[illegible]	24	
12	[illegible]	[illegible]	8630	[illegible]	621 0	[illegible]	
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
14	[illegible]	[illegible]	9343	[illegible]	[illegible]	14	Repairs to pump
15	3017	[illegible]	9358	[illegible]	[illegible]	[illegible]	
16	[illegible]	[illegible]	9850	[illegible]	[illegible]	24	
17	[illegible]	[illegible]	[illegible]	[illegible]	608 0	24	
18	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
19	[illegible]	[illegible]	[illegible]	531		24	
20	[illegible]	[illegible]	[illegible]	[illegible]		24	
21	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
22	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
23	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
24	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
25	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
26	[illegible]	[illegible]	13042	[illegible]		[illegible]	
27	4228	[illegible]	[illegible]	[illegible]		18	Time worked cut down to 18 hours, on account of depth. Six [illegible] working three hours each
28	[illegible]	[illegible]	[illegible]	[illegible]		18	
29	[illegible]	[illegible]	[illegible]	[illegible]		18	
30	[illegible]	[illegible]	[illegible]	[illegible]		18	
Oct. 1	4605	3811	14838	[illegible]		18	
2	[illegible]	[illegible]	[illegible]	[illegible]		11	Sand pumps shut down at 11 00 A. M. Concreting begun.
3	[illegible]	[illegible]	[illegible]	[illegible]			Concreting
4	[illegible]	[illegible]	15370	[illegible]			
10	4580	[illegible]	15370	[illegible]			Concreting finished. Air taken off at 8·30 P. M.

Total number of hours pumped. .... 850½ Average distance per hour's pumping, $\frac{10086}{100000}$ feet.

APPENDIX D.—CONTINUED.

RECORD OF SINKING CAISSONS.

PIER V.

READINGS TAKEN AT 8 A. M.

Date	Elevation of Cutting Edge: N. E.	N. W.	S. W.	S. E.	Average	Sunk in 24 Hours, Feet	Elevation of Sand: N. E.	N. W.	S. W.	S. E.	Average	Average Penetration of Caisson, Feet	Water Gauge	Depth Immersed, Feet	Elevation of Top of Pier
June 13	678.50	678.54	678.52	[illegible]	678.52							.....	676.33		683.5
14	666.89	666.89	667.19	666.93	666.98	11.54	665.1	665.9	667.1	666.0	666.00	....	676.03	9.05	682.0
15	[illegible]	665.34	666.53	666.22	665.81	1.17	666.6	666.0	667.7	666.5	666.67	0.86	675.45	9.64	680.4
16	663.93	[illegible]	664.56	664.19	664.21	1.60	[illegible]	665.9	667.9	665.1	666.25	2.04	675.17	10.96	682.2
17	662.38	[illegible]	662.08	662.07	662.21	2.00	665.0	664.9	668.5	664.9	665.82	3.61	675.13	12.92	679.2
18	659.28	659.35	660.15	659.97	659.69	2.52	664.2	664.3	666.2	664.3	664.75	5.06	675.44	15.75	679.2
19	656.70	656.94	658.50	658.16	657.57	2.12	664.4	664.4	666.3	666.9	665.50	7.93	675.70	18.13	680.6
20	653.67	654.09	654.15	653.60	653.88	3.69	662.7	664.3	666.1	663.6	664.18	10.30	675.76	21.88	680.4
21	648.76	649.17	649.66	649.16	649.19	4.69	662.6	662.3	664.7	665.4	663.75	14.56	675.89	26.70	679.2
22	642.84	642.86	643.69	643.57	643.24	5.95	664.8	662.1	664.7	668.2	664.95	21.71	675.57	32.33	677.5
23	640.90	640.93	641.25	641.12	641.05	2.19	662.7	[illegible]	666.2	667.9	664.75	23.70	675.78	34.73	679.5
24	638.61	638.75	639.20	638.97	638.88	2.17	662.2	663.6	665.3	667.6	664.42	25.54	676.20	37.32	682.4
25	637.16	637.31	637.57	637.27	637.32	1.56	661.7	[illegible]	666.7	666.1	664.30	26.98	676.65	39.33	682.8
26	635.31	[illegible]	635.86	635.61	635.55	1.77	660.4	662.3	667.4	665.2	663.82	28.27	676.70	41.15	683.5
27	632.54	632.70	633.29	633.07	632.90	2.65	[illegible]	662.6	668.6	664.1	663.70	30.80	677.13	44.23	682.4
28	630.36	630.34	630.76	630.44	630.48	2.42	[illegible]	662.9	[illegible]	664.0	663.72	33.24	677.92	47.44	684.4
29	630.31	630.29	630.56	630.32	630.35	0.13	[illegible]	663.2	669.5	664.5	663.92	33.57	678.22	47.87	684.4
30	627.17	627.15	627.85	627.69	627.45	2.90	[illegible]	[illegible]	669.3	667.5	664.00	36.55	677.66	50.21	681.7
July 1	625.04	625.03	625.81	625.70	[illegible]	2.03	657.0	664.4	670.6	670.6	665.65	40.23	676.70	51.28	679.4
2	623.50	623.43	[illegible]	624.15	[illegible]	1.60	657.3	664.5	669.3	668.5	664.90	41.08	676.34	52.52	677.8
3	622.32	622.19	622.87	622.82	622.55	[illegible]	657.3	663.1	671.4	673.4	666.30	43.75	677.10	54.55	678.8
4	622.33	622.29	622.64	622.64	622.48	0.07	658.0	664.6	670.7	670.4	667.17	44.69	677.32	54.84	680.4
5	622.33	622.29	622.64	622.64	622.48	0.00	657.5	668.2	670.4	670.0	666.52	44.04	676.75	54.27	680.4
6	621.34	621.25	621.56	621.56	621.43	1.02	656.5	667.1	671.3	672.8	667.43	46.00	676.35	54.92	683.4
7	621.34	621.25	621.56	621.59	621.44	[illegible]	655.5	667.0	671.4	672.8	[illegible]	[illegible]	676.12	54.68	685.4
8	620.47	620.38	620.61	620.65	620.53	[illegible]	660.9	668.4	673.1	674.9	669.33	48.80	676.42	55.89	684.7
9	620.47	620.38	620.61	620.65	620.53	0.00	667.6	668.8	673.3	675.2	671.23	50.70	676.75	56.22	684.7
10	618.91	618.87	618.91	619.01	618.92	1.61	669.3	671.0	673.1	674.7	672.25	53.33	676.95	58.03	683.1
11	618.91	618.88	618.89	619.01	618.92	0.00	671.0	670.3	673.1	675.3	672.38	53.46	676.30	57.38	683.1
12	618.91	618.88	618.89	619.01	618.92	0.00	670.4	672.0	672.2	674.8	672.35	53.43	675.55	56.63	683.1
13	617.49	617.39	617.38	617.48	617.43	[illegible]	669.7	670.8	672.9	673.5	671.73	54.30	674.75	57.32	681.6
14	616.52	616.46	616.41	616.53	616.48	0.95	669.7	673.4	671.2	671.7	671.50	55.02	674.45	57.97	680.7
15	615.81	615.76	615.67	[illegible]	615.76	0.72	672.4	[illegible]	[illegible]	[illegible]	673.07	57.31	647.00	58.24	680.0
16	615.80	615.75	615.67	615.80	615.76	0.00	673.4	673.6	676.0	[illegible]	673.73	57.97	674.00	58.24	680.0
17	614.88	614.86	614.75	614.86	614.84	0.92	672.4	674.0	676.0	[illegible]	673.72	58.88	674.06	59.22	679.0
18	614.04	614.03	613.88	613.97	613.98	0.86	672.2	674.3	677.0	672.2	673.92	59.94	673.95	59.97	680.3
19	613.78	613.73	613.64	613.73	613.72	0.26	[illegible]	674.1	677.0	671.7	673.65	59.93	673.95	60.23	[illegible]
20	613.01	612.96	612.88	612.97	612.96	[illegible]	[illegible]	[illegible]	676.4	671.0	673.32	60.36	673.75	[illegible]	679.2
21	613.01	612.96	612.98	612.96	612.95	[illegible]	[illegible]	674.7	676.7	671.7	673.02	60.07	673.75	60.80	[illegible]
22	612.24	612.21	612.10	612.18	612.18	[illegible]	[illegible]	671.6	673.4	672.0	672.18	60.00	673.75	61.57	678.5
23	612.24	612.21	612.10	612.18	612.18	0.00	670.4	671.7	675.5	670.6	672.05	59.87	673.94	61.76	678.5
24	611.52	611.49	611.38	611.46	611.46	[illegible]	669.4	671.6	674.9	670.2	671.52	60.06	673.00	61.54	[illegible]
25	611.22	611.19	[illegible]	611.16	611.16	0.30	669.4	671.6	674.9	670.2	671.52	60.36	673.30	62.14	677.5
26	611.22	611.19	611.09	611.16	611.16	0.00	668.4	670.6	[illegible]	670.5	671.35	60.19	673.26	62.10	677.5
27	610.24	610.21	[illegible]	610.15	610.16	1.00	[illegible]	[illegible]	674.6	670.6	671.52	61.36	672.70	62.54	676.5
28	610.13	[illegible]	609.97	610.04	610.06	0.10	670.1	670.6	674.5	670.5	671.42	61.36	672.60	62.54	676.4
29	609.94	[illegible]	609.79	609.87	609.88	0.18	[illegible]	671.5	[illegible]	668.3	[illegible]	61.17	672.42	62.54	676.2
Aug 3	609.94	609.90	609.79	609.87	609.88										

Date	Weights, Tons: Caisson	Crib	Masonry	External Sand	Water	Total	Air Pressure, Pounds: Indic'd	Calc'd	Reduction due to Air Pressure, Tons	Net Weight, Tons	Surface in Contact, Square Feet	Average Wt. per Sq. Ft. of Surface Exposed to Friction, Lbs.	Material	Hours Worked by Sand Pump	Remarks
June 13	147					147			.	147					Caisson suspended by screws. Commenced lowering at 7:00 A. M.
14	241					241	.	.		241				..	Air put on at 9 15 A. M.
15	363					363	4.00	4.176	345	18	123	[illegible]	[illegible]		Screws taken off at 7 00 A. M.
16	490	95				585	4.50	[illegible]	[illegible]	[illegible]	[illegible]	1317		12¼	Sand pump started at 10 45 A. M.
17	524	[illegible]				756	4.50	[illegible]	463	[illegible]	518	1131		20¼	" " stopped, to remove logs.
18	524	386			4	914	6.75	6.822	564	350	726	964		24	
19	524	564			17	1105	8.00	7.854	649	456	1137	802		24	
20	524	743			38	1305	9.25	9.478	784	521	1477	705		24	
21	524	961			64	1549	11.00	11.566	956	593	2088	570	643 0	24	
22	524	1182		65	58	1829	13.50	14.005	1158	671	3114	431		9	
23	524	1400		77	61	2062	15.00	[illegible]	1244	810	[illegible]	[illegible]	Blue Mud.	24	
24	524	1573		102	65	2264	15.50	16.167	1326	928	3663	507		24	
25	524	1740		114	69	2447	17.50	17.038	1408	1039	3870	[illegible]	637 0	[illegible]	Sand pump out of order
26	524	1860		129	7	2584	18.00	17.826	1474	1110	4055	547	Sand & Mud	24	
27	524	2039		155	73	2791	[illegible]	19.160	1584	1207	[illegible]	[illegible]	633 0	[illegible]	Sand pump stopped at 5:30 P. M.
28	524	2068		177	78	2847	20.00	20.551	[illegible]	1148	4767	482	[illegible]	5	Moving sand pump
29	524	2068		180	[illegible]	[illegible]	21.00	20.737	[illegible]	[illegible]	[illegible]	472		24	
30	524	2068		208	75	2875	21.50	[illegible]	[illegible]	1077	5242	411	627 0	9	Hoisting clay.
July 1	524	2068		245	[illegible]	2898	22.00	22.214	836	1062	5770	368	Sand & Mud	23	" "
2	524	2068		253	63	2908	22.25	22.75	[illegible]	[illegible]	5892	349	624 0	8	"
3	524	2068	100	[illegible]	64	3035	23.00	23.630	1953	1082	[illegible]	345	623 0	24	" "
4	524	2068	176	188	67	3123	23.50	23.757	1964	1159	[illegible]	362		1	" "
5	524	2068	177	262	59	[illegible]	23.50	23.509	[illegible]	1167	[illegible]	[illegible]			" "
6	524	2068	316	305	59	3272	23.00	[illegible]	[illegible]	1305	[illegible]	[illegible]			" "
7	524	2068	389	305	59	3341	[illegible]	23.688	1958	383	[illegible]	419	Blue Clay	.	" "
8	524	2068	389	[illegible]	59	3369	24.50	[illegible]	2001	1368	[illegible]	391			Clay hoist started at 3:30 P. M.
9	524	2068	389	[illegible]	53	3302	24.50	24.334	2013	369	[illegible]	377			
10	524	2068	389	377	75	3426	25.25	25.138	2075	1350	7649	353	618 9		
11	524	2068	389	373	62	[illegible]	25.00	24.857	2055	1361	7668	355	Sand and Gravel		
12	524	2068	389	373	47	3401	25.50	24.532	2028	[illegible]	7663	358		11	Clay hoist stopped at 2.30 A. M. Run 83 hours.
13	524	2068	389	378	57	3416	25.00	24.831	2053	[illegible]	[illegible]	350	617 4	8½	Sand pump stopped at 8:20 A. M. Clay hoist started at 3:30 P. M.
14	524	2068	389	[illegible]	60	3438	25.00	25.113	[illegible]	[illegible]	7591	[illegible]			Clay hoist stopped from 7.00 to 9:45 A. M.
15	524	2068	389	478	[illegible]	3477	25.00	25.230	2086	391	[illegible]	338			
16	524	2068	389	502	6	3489	25.00	25.230	2086	403	8314	338			
17	524	2068	389	536	9	3526	25.00	25.654	2121	405	[illegible]	333			
18	524	2068	[illegible]	577	.	3658	25.00	25.979	2147	1511	8597	339			
19	524	2068	489	[illegible]	7	[illegible]	25.00	26.091	2157	1508	[illegible]	338			
20	524	2068	489	592	9	[illegible]	25.00	26.334	2177	1505	[illegible]	348			
21	524	2068	489	[illegible]	15	[illegible]	25.00	26.338	2177	1500	[illegible]	348			
22	524	2068	489	579	[illegible]	[illegible]	25.00	26.672	2205	1490	8606	346			
23	524	2068	489	570	43	[illegible]	25.00	26.754	2212	[illegible]	8587	344	Blue Clay		
24	524	2068	489	581	47	3709	25.00	26.659	2204	1505	8614	349			
25	524	2068	489	592	33	3708	25.00	26.919	2225	483	8657	343			
26	524	2068	489	586	39	[illegible]	25.00	26.901	2224	[illegible]	8633	343			
27	524	2068	489	632	36	[illegible]	25.00	[illegible]	2240	1499	8800	341			
28	524	2068	489	632	36	[illegible]	25.00	27.092	2240	1499	8800	341			Clay hoist stopped at 8:55 A. M. Run 302 hours.
29	524	2068	489	670	33	[illegible]	25.00	[illegible]	2240	1494	8773	341			Caisson settled to final position at 9:00 A. M.
Aug 3															Air taken off at 6 00 P. M.

Total number of hours pumped............ | 383¼ | Average distance sunk per hour's pumping, $\frac{14187}{100000}$ feet

APPENDIX E.

SPECIFICATIONS FOR SUPERSTRUCTURE.

GENERAL DESCRIPTION.

The superstructure will consist of three main through spans and two deck spans, one at each end of the structure.

Each through span will be 400 feet long between centers of end pins, divided into 15 panels of 26 feet 8 inches each. The trusses will be 50 feet deep, and placed 22 feet apart between centers. Each span will weigh approximately 1,100,000 pounds.

The east deck span will be a plate girder about 50 feet long. The west deck span will be 133 feet long between centers of end pins, and divided into 5 panels of 26 feet 8 inches each, the trusses being placed 12 feet apart between centers.

PLANS.

Full detail plans, showing all dimensions, will be furnished by the engineer. The work shall be built in all respects according to these plans. The contractor, however, will be expected to verify the correctness of the plans, and will be required to make any changes in the work which are necessitated by errors in these plans, without extra charge, where such errors could be discovered by an inspection of the plans.

MATERIALS.

All parts, except nuts, swivels, wall pedestal plates and ornamental work, will be of steel. The nuts and swivels may be of wrought iron; the pedestal plates and ornamental work of cast iron. The web plates of the east approach span may be of wrought iron.

All materials shall be subject to inspection at all times during their manufacture, and the engineer and his inspectors shall be allowed free access to any of the works in which any portion of the material is made. Timely notice shall be given to the engineer, so that inspectors may be on hand.

Steel may be made by the open hearth or by the Bessemer process, but no steel shall be made at works which have not been in successful operation for at least one year. Steel made by the Clapp-Griffiths process will not be accepted. All melts shall be made from uniform stock low in phosphorus, and the manufacturer shall furnish satisfactory evidence to the engineer that this class of material is being employed, it being understood that the furnished product is to be one in which the phosphorus does not average more than $\frac{8}{100}$ of one per cent., and never exceeds $\frac{1}{10}$ of one per cent.

A sample bar, $\frac{3}{4}$ inch in diameter, shall be rolled from every melt. The method of obtaining the piece from which this sample bar is rolled shall be the same for all samples, and the amount of work on this sample bar shall be as nearly as practicable the same as on the finished product. The laboratory tests shall be made on this sample bar in its natural state without annealing.

The laboratory tests of steel made on the sample bar shall show an elastic limit of not less than 40000 pounds per square inch; an ultimate strength of not less than 67000 pounds nor more than 75000 pounds; an elongation of at least 20 per cent. in a length of 8 inches; and a reduction of at least 42 per cent. at the point of fracture; this elongation and reduction being the minimum and not the average requirements. In a bending test the sample bar shall bend 180 degrees and close back against itself without showing crack or flaw on the outside of the curve. Steel having an ultimate strength of 60000 pounds per square inch will be accepted for rivets.

Should the contractor desire to use British steel, the quenching and bending tests specified in the Hawksbury Bridge specifications will be required, and the elastic limit requirement may be waived.

Every piece of steel shall be stamped with a number identifying the melt, and a statement of the results of the laboratory tests of each melt shall be furnished by the contractor, certified by some person acceptable to the engineer, and accompanied by the tested specimens. Tests shall also be made from time to time on samples cut from finished plates, shapes and bars, which shall show results substantially conforming to those shown by the sample tests of the same melts.

All sheared edges or punched holes in steel work shall be subsequently planed or drilled out, so that none of the rough surface is ever left upon the work. Steel for pins shall be sound and entirely free from piping, and pins more than 4 inches in diameter shall be drilled through the axis.

Wrought Iron. Small samples, having a minimum length of 8 inches, taken from the iron of the web plates of the east approach span, shall show an elastic limit of at least 24000 lbs., an ultimate strength of at least 47000 lbs. per square inch, an elongation of at least 8 per cent., and a reduction of 12 per cent. at the point of fracture.

Cast iron shall be the best quality of tough, gray iron.

RIVETED WORK.

All plates, angles and channels, shall be carefully straightened before they are laid out; the rivet holes shall be carefully spaced in truly straight lines; the rivet heads shall be of hemispherical pattern, and the work shall be finished in a neat and workmanlike manner. Surfaces in contact shall be painted before they are put together. The dimensions given for rivets on the plans are the diameters of the rivets before driving.

Power riveters shall be direct acting machines, capable of exerting a yielding pressure, and holding on to the rivet when the upsetting is completed.

The several parts of each member shall be assembled, and the holes shall be drilled, the sharp edge of the drilled hole shall be trimmed so as to make a slight filiet under the rivet head, and the pieces shall be riveted together without taking apart. Should the contractor desire, the parts may be punched with a punch at least $\frac{1}{16}$ inch smaller than the diameter of the rivet as given on the plans, working in a die only $\frac{1}{16}$ inch larger than the punch; the several parts of the member shall then be assembled and the holes reamed so that at least $\frac{1}{8}$ inch of metal is taken out all round, and the sharp edge of the reamed hole shall be trimmed, and the pieces riveted together as above. All rivets shall be of steel; the rivet holes shall be of such size that the rivets will fill the hole before driving, and, whenever possible, they shall be driven by power. All bearing surfaces shall be truly faced. The chord pieces shall be fitted together in the shop, in lengths of at least five panels, and marked. When so fitted there shall be no perceptible wind in the length laid out. The pin holes shall be bored truly, so as to be at exact distances, parallel with one another, and at right angles to the axis of the member.

The holes for the rivets connecting the floor-beams with the posts and bolsters and the stringers with the floor-beams, and, in general, the holes for all rivets which must be driven after erection, shall be accurately drilled to an iron templet. The holes for the rivets connecting the floor-beams with the posts shall be 1 inch in diameter, and the rivets of corresponding diameter. The pin holes in the vertical posts shall be truly parallel with one another, and at right angles to the axis of the posts. The posts shall be straight and free from wind.

FORGED WORK.

The heads of eye-bars shall be formed by upsetting and forging into shape by such process as may be accepted by the engineer. No welds will be allowed. After the working is completed, the bars shall be annealed by heating them to a uniform dark-red heat throughout their entire length, and allowing them to cool slowly. The form of the heads of steel eye-bars may be modified to suit the process in use at the contractor's works, but the form of the head adopted must be such as to meet the requirements of the tests of full-sized bars.

The heads and the enlarged ends for screws in laterals, suspenders and counters, shall be formed by upsetting by a process acceptable to the engineer.

APPENDIX E.—Continued

TESTS OF FULL-SIZED STEEL BARS.

Ten full-sized eye-bars of sections and lengths, used in the actual work, shall be selected from bars made for the bridge, by the inspector for testing. Each of these full-sized bars shall be strained till an elongation of 10 per cent. is obtained, and, if possible, broken. If broken, the fracture shall occur in the body of the bar, and shall show a uniform and ductile quality of material.

The contractor will be required to furnish facilities for testing the full-sized bars within a reasonable distance of his works. Should the contractor be unable to furnish such facilities, he shall be required to furnish bars of 20 per cent. larger sections than those called for, without charge for the increased weight.

The full-sized bars shall be selected from time to time as the work proceeds, the last bar not to be selected till all the eye-bars are manufactured. The tests shall be made from time to time as the bars are selected. When three bars have been tested, the bars manufactured up to the time of the selection of these three test-bars shall be accepted or rejected on the results of such tests, and the same shall be done again when three more bars are tested. In these tests, the failure of one bar to develop a stretch of 8 per cent., or of the lot to develop an average of 10 per cent. before breaking, shall be sufficient reason for rejecting the lot from which these bars are taken. A failure to break in the body of the bar shall not be a sufficient ground for condemnation if it does not occur in more than one-third of the bars tested, but the above requirements as to elongation shall apply to the bars so breaking in the head, as well as to the others. The engineer shall, however, examine carefully into the cause of breakage of any bars which do meet the requirements, and, if the defect is explained, may order additional tests, and make the acceptance dependent on further results.

MACHINE WORK.

The bearing surfaces in the top chord shall be truly faced. The ends of the stringers and of the floor-beams shall be squared in a facer. All surfaces, so designated on the plans, shall be planed. All sheared and punched edges shall be planed or bored out.

All pins shall be accurately turned to a gauge, and shall be of full size throughout. Pin holes shall be bored to fit the pins, with a play not exceeding $\frac{1}{32}$ of an inch. These clauses apply to all lateral connections as well as to those of the main trusses. Pins shall be supplied with pilot nuts, for use during erection—four of each size of pin.

All screws shall have a truncated V thread, United States standard sizes.

MISCELLANEOUS.

All workmanship and material, whether particularly specified or not, must be of the best kind now in use in first-class bridge work. Flaws, ragged edges, surface imperfections, or irregular shapes, will be sufficient ground for rejection. Rough and irregularly finished work will not be accepted.

Machine finished surfaces shall be coated with white lead and tallow before shipment. All other parts shall be given a coat of hot boiled linseed oil.

TERMS.

Monthly estimates will be made at the end of each month for the work done during that month. In these monthly estimates, the material delivered at the contractor's shop, but not manufactured, shall be estimated at 50 per cent. of the contract price for finished material in Chicago, and manufactured material at 75 per cent. of the contract price for finished material in Chicago. Payments will be made on or about the 15th day of the following month, according to these estimates, deducting from the amount of the same 10 per cent. as security, to be held until the completion of the entire contract.

No material will be paid for which does not form a part of the permanent structure.

All expenses of testing shall be borne by the contractor.

TIME.

The east approach span shall be completed and shipped not later than January 1, 1888. The three through spans shall be completed and shipped in January, March and May, 1888, respectively. The west approach span shall be completed and shipped in April, 1888. The Bridge Company may exact a penalty, not exceeding $150 per day, for failure to complete the work at these specified times.

MORISON & CORTHELL,

Chief Engineers Sioux City Bridge.

CHICAGO, June 15, 1887.

APPENDIX F.

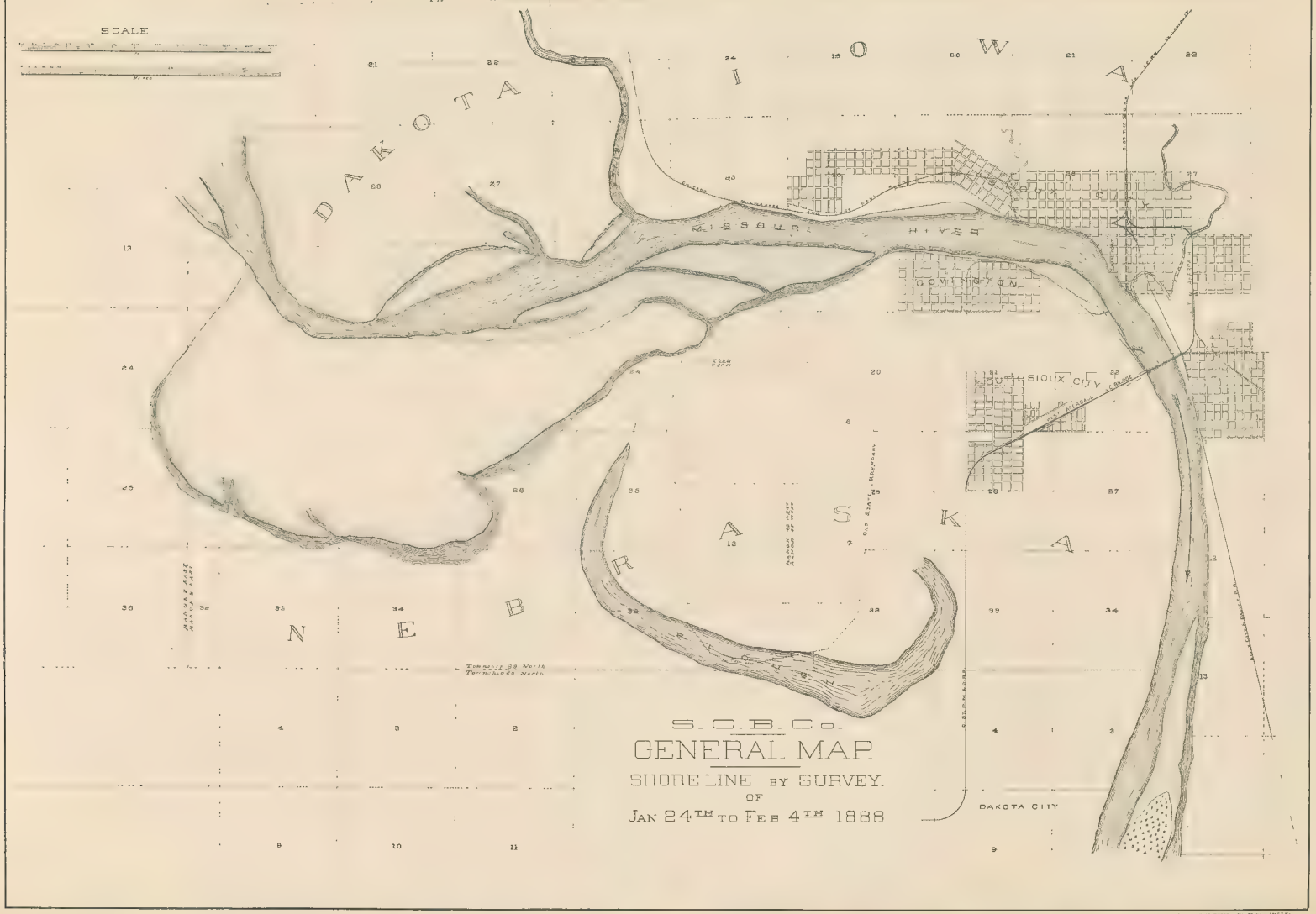
TESTS OF STEEL EYE-BARS.

TESTS ON FULL-SIZED EYE BARS

Dimensions—Inches. Original. Nominal Width	Nominal Thickness	Actual Length, Cut	Actual Gauged Length	Actual Width	Actual Thickness	After Testing Width	After Testing Thickness	Results of Mechanical Tests. Reduction of Area Per Cent.	Elongation. Inches	Elongation. Per Cent.	Elastic Limit Lbs. per sq. in.	Maximum Load Lbs. per sq. in.	Place of Fracture
4	⅝	441 98	372	3 98	0.74	3 00	0.40	59.10	39 0	10 50	58,150	61,050	Body.
-	$2^{1}/_{8}$	320.18	276	7.06	2 10	5.26	1.37	51 30	41 8	15.14	35,070	63,265	"
7	$2^{1}/_{2}$	319.98	276	7.10	2 11	5.22	1.26	56.07	51.0	18.50	33,900	59,230	"
7	$1^{3}/_{4}$	320 08	276	7.11	1 76	5.33	1.12	42 30	38 3	13 90	33,750	58,690	"
7	$1^{3}/_{4}$	319.88	276	7.19	1 74	5.63	1.28	41 70	35 4	12.80	37,590	67,440	"
6	1	320.18	276	6 03	1.00	4 52	0.54	59 30	36 4	13 20	37,880	60,210	"
6	1	320 13	276	6 03	1 00	4.68	0 63	51 10	40.3	14 60	36,870	60,880	"
5	$1^{1}/_{4}$	438.83	396	5.07	1 23				17.5	4.40	40,200	47,850	Head
5	$1^{1}/_{4}$	438.78	396	5.07	1.23	3.70	0.75	55.60	56 1	14.20	35,950	61,120	Body.
5	1	251 48	216	5.06	1 00	3.88	0.62	52 40	29 7	13 70	40,310	64,900	"
5	$1^{1}/_{4}$	439.78	396	5.05	1 22	3.77	0.87	44 70	59.8	15.10	35,760	63,570	"
4	⅞	435 08	384	4.05	0.76	3.08	0.53	47.10	55.2	14.40	34,430	54,300	"
4	⅞	430.78	384	4 04	0.74	2.97	0.47	53.30	57.2	14 90	35,470	59,345	"
7	$2^{1}/_{8}$	320.08	288	7 05	2 06	5.45	1 43	46.35	38 6	13.40	32,170	60,400	·
6	1	320.08	288	6 00	1 02	4.41	1.02	49.56	33 8	11.73	34,660	58,660	"
7	$1^{3}/_{4}$	320 03	288	7 05	1 75	5.45	1.26	44 33	51.7	17.95	33,390	62,640	"

TESTS ON SAMPLE BARS FROM SAME MELTS.

Diameters. Original Inches	Diameters. After Testing Inches	Reduction Per Cent	Elongat'n Per Cent.	Elastic Limit Lbs. per sq. in	Maximum Load Lbs. per sq. in.	Per cent of Phosphorus.	Heat Number	
							.....	Scotch Stee.
							18,090	
							21,498	
							21,505	
							21,505	
.755	518	52.94	26.75	41,550	70,250	0.075	8,100	
755	520	52.56	28 26	40,880	68,350	0.065	8,095	
.752	.550	46.50	25.50	41,430	69,800	0.080	25,354	
756	543	48.03	23 25	41,660	70,840	0.074	25,350	
755	.520	52 56	22.50	41,550	69,910	0 080	25,320	
							.....	Scotch Stee.
							.....	Scotch Steel



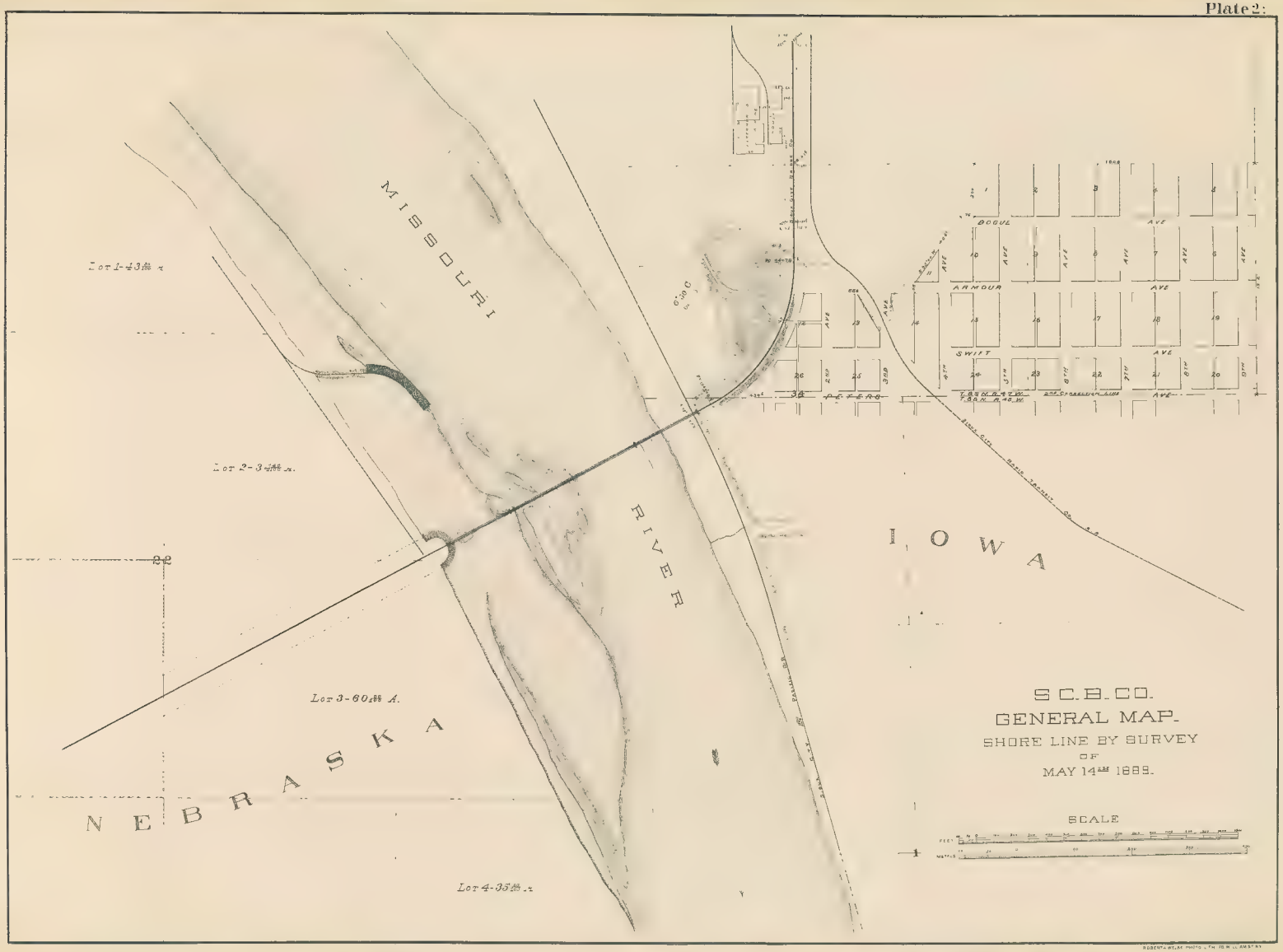
S. C. B. Co.

GENERAL MAP.

SHORE LINE BY SURVEY.

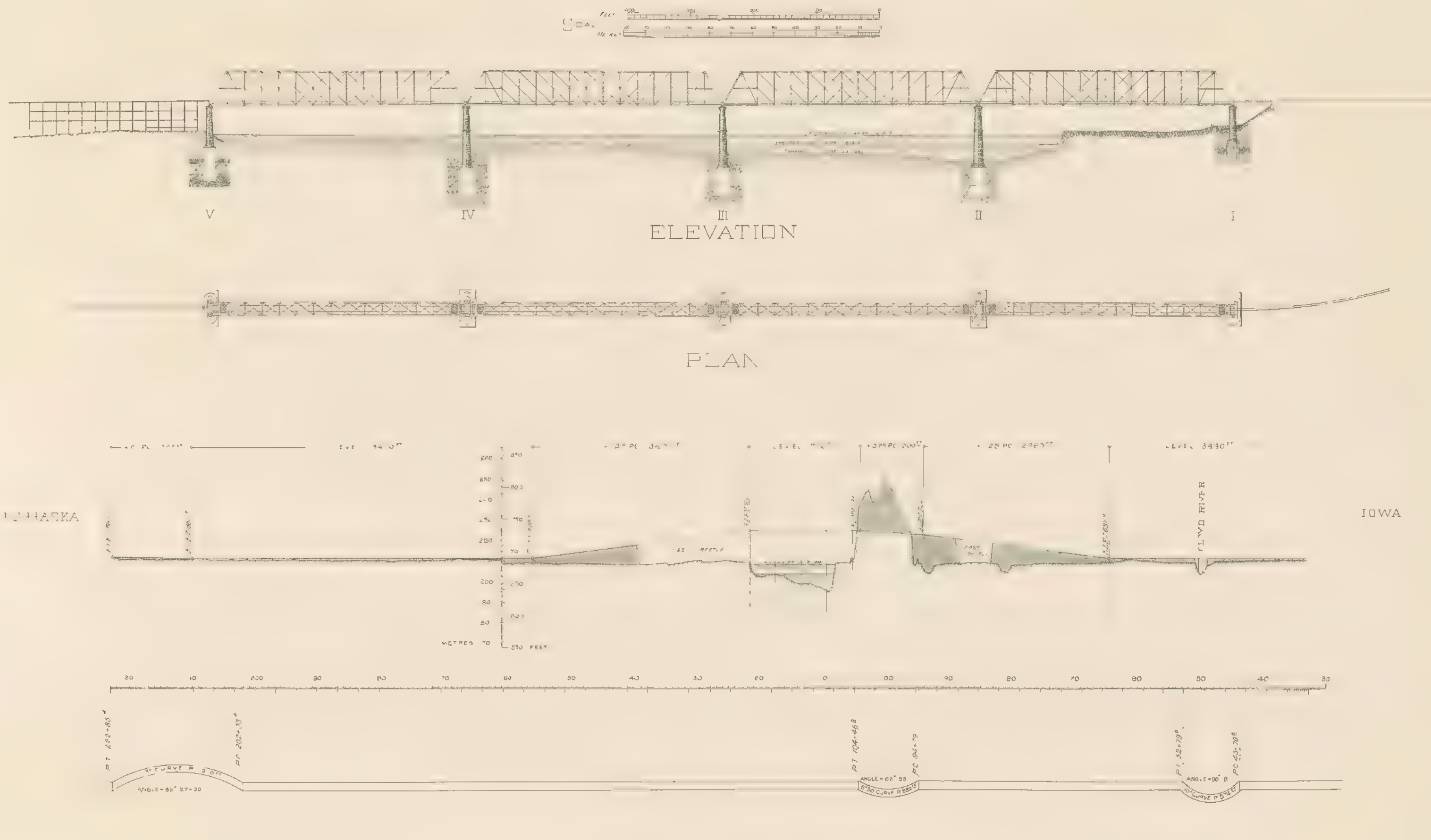
OF

JAN 24TH TO FEB 4TH 1888


MISSOURI
RIVER
IOWA
NEBRASKA
Lot 1-43 1/100 A.
Lot 2-3 4/100 A.
Lot 3-60 1/100 A.
Lot 4-35 1/100 A.
BOGUE AVE
ARMOUR AVE
SWIFT AVE
SC.B.CO.
GENERAL MAP.
SHORE LINE BY SURVEY
OF
MAY 14TH 1889.
SCALE

S. C. B. CO.

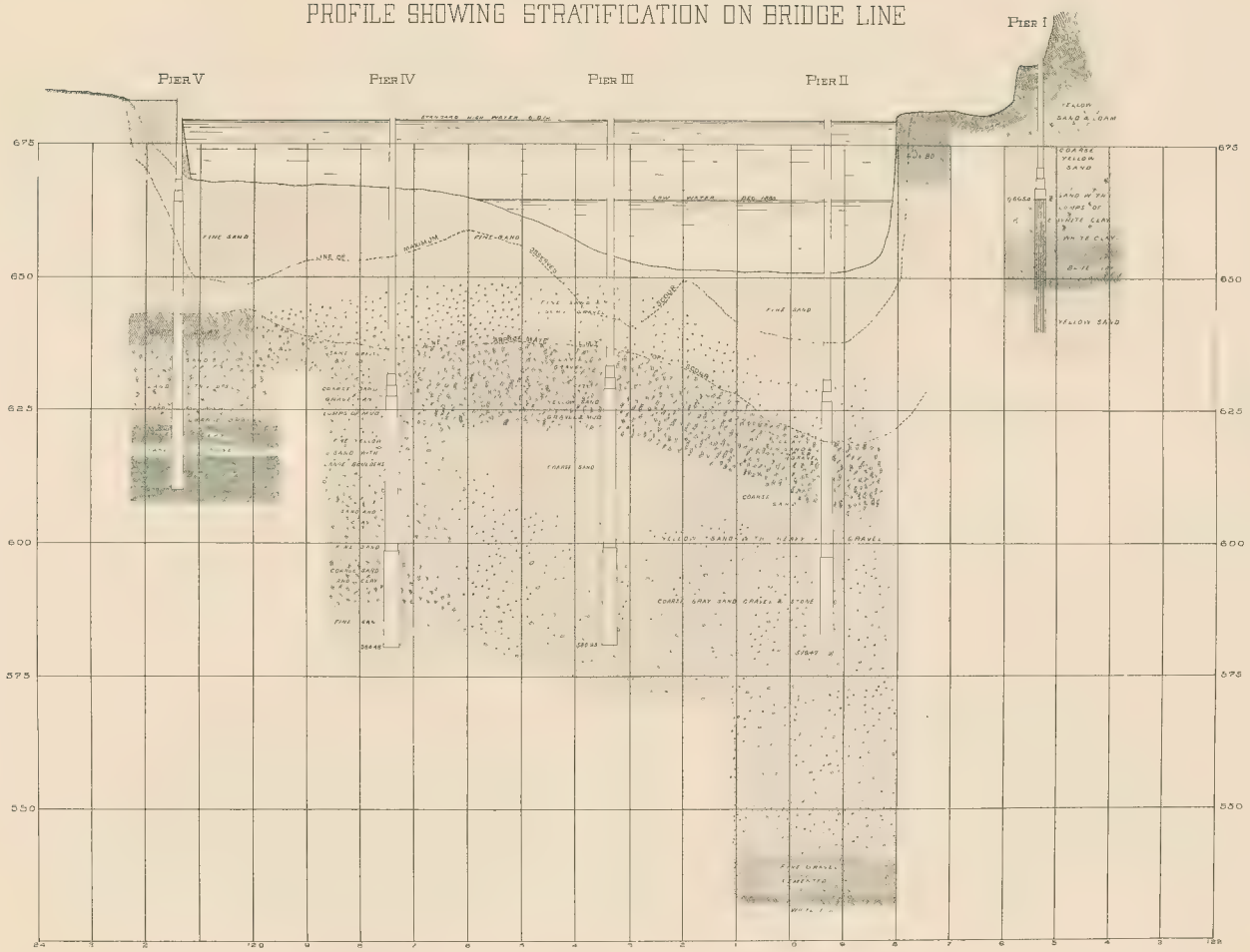
GENERAL ELEVATION, PLAN, PROFILE & ALIGNMENT



PROFILE & ALIGNMENT

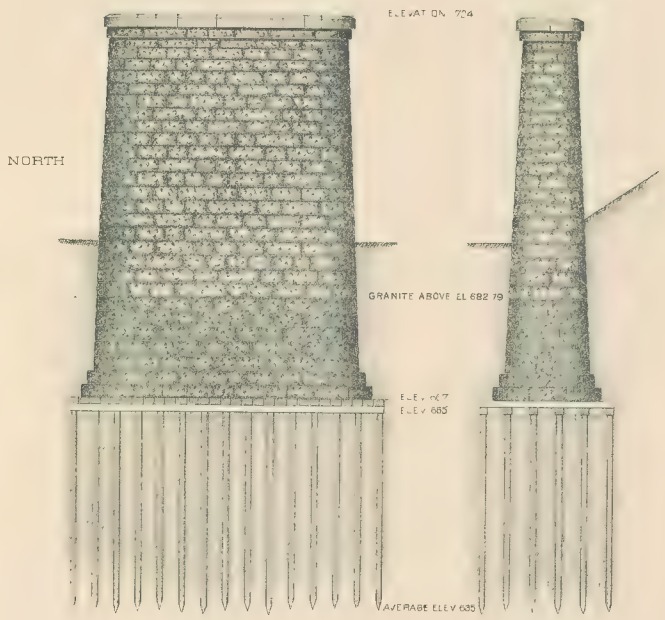
S. O. B. CO.

PROFILE SHOWING STRATIFICATION ON BRIDGE LINE



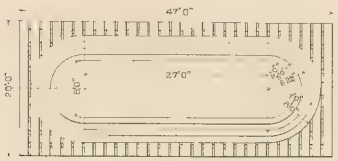
S.C.B.CO.

PIER I & EAST ABUTMENT



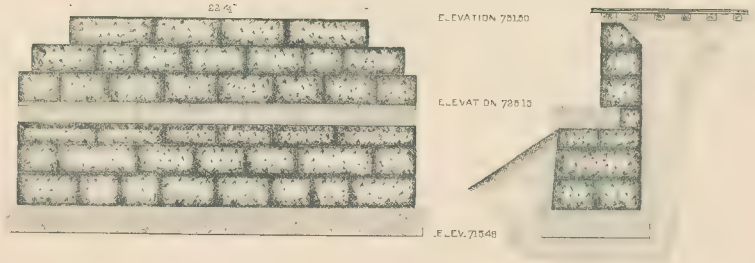
PIER Nº I.
SIDE ELEVATION

PIER Nº I.
END ELEVATION.



PIER Nº I
PLAN

SCALE

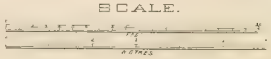


EAST ABUTMENT.
SIDE ELEVATION.

EAST ABUTMENT.
END ELEVATION

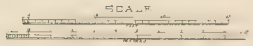
EAST ABUTMENT
PLAN.

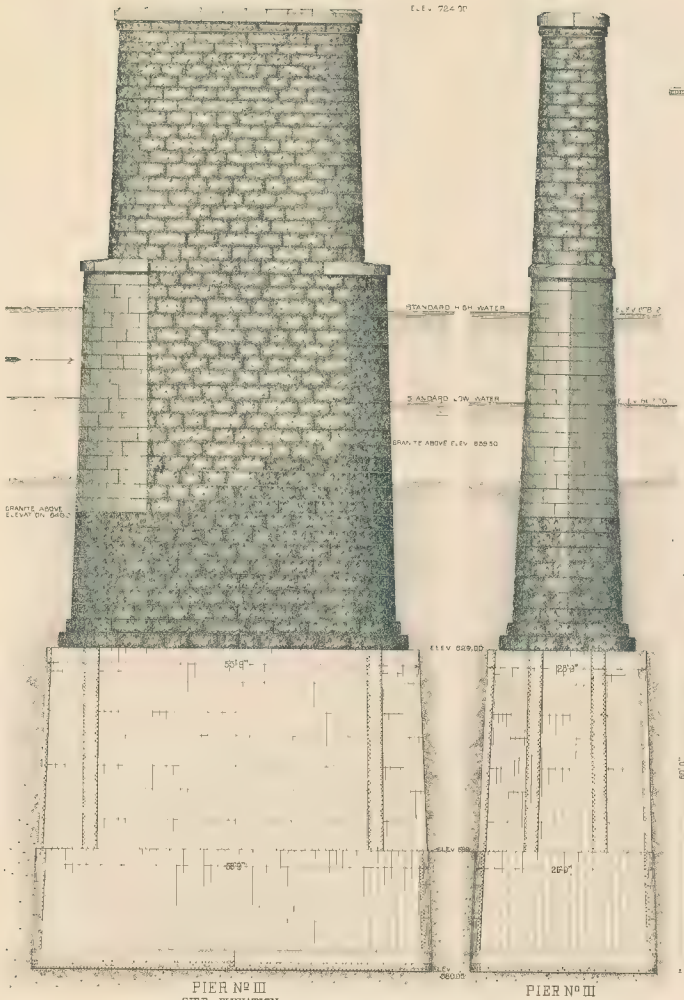
SCALE.



S. C. B. CO.

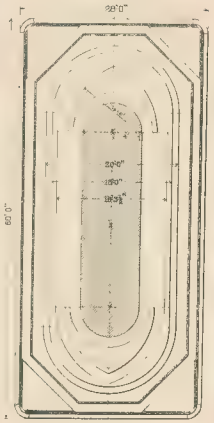
Piers II & III



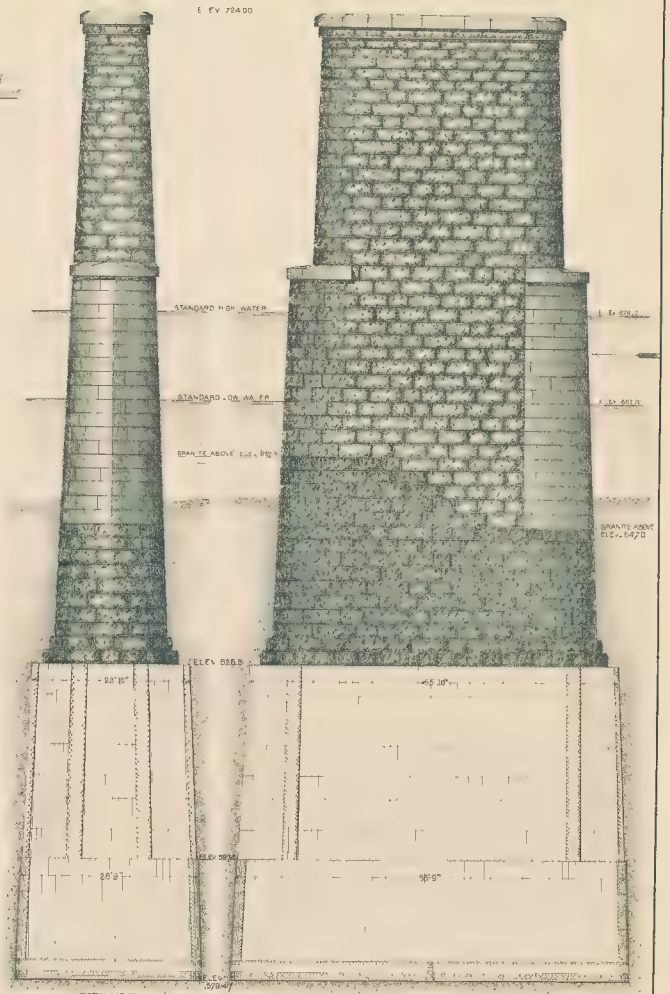


PIER No III
SIDE ELEVATION

PIER No III
END ELEVATION.



PLAN UNDER COPING

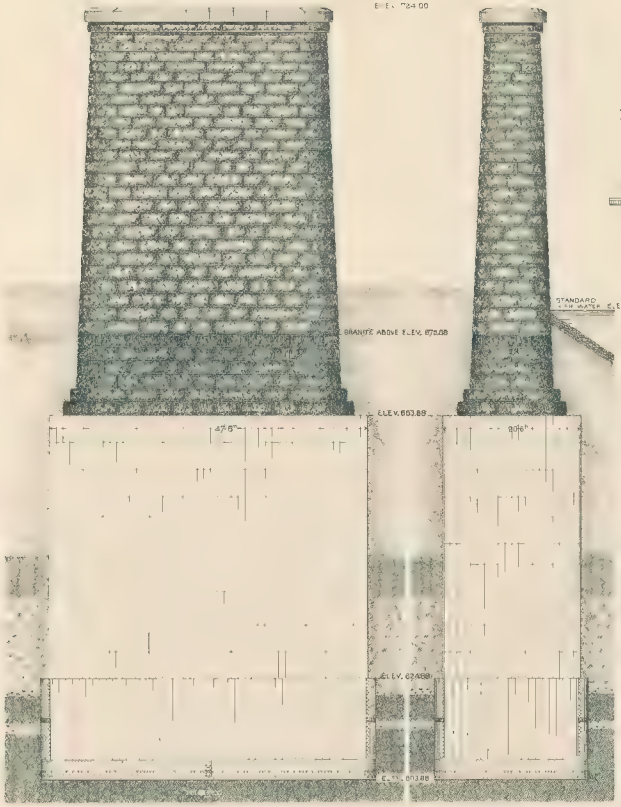


PIER No II
END ELEVATION.

PIER No II
SIDE ELEVATION

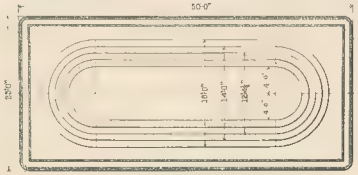
S.O.B.CO.
PIERS IV & V.

SCALE

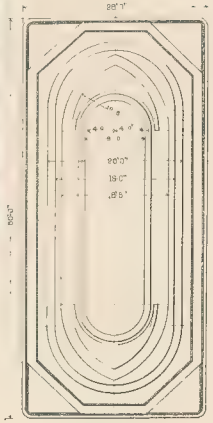


PIER Nº V
SIDE ELEVATION

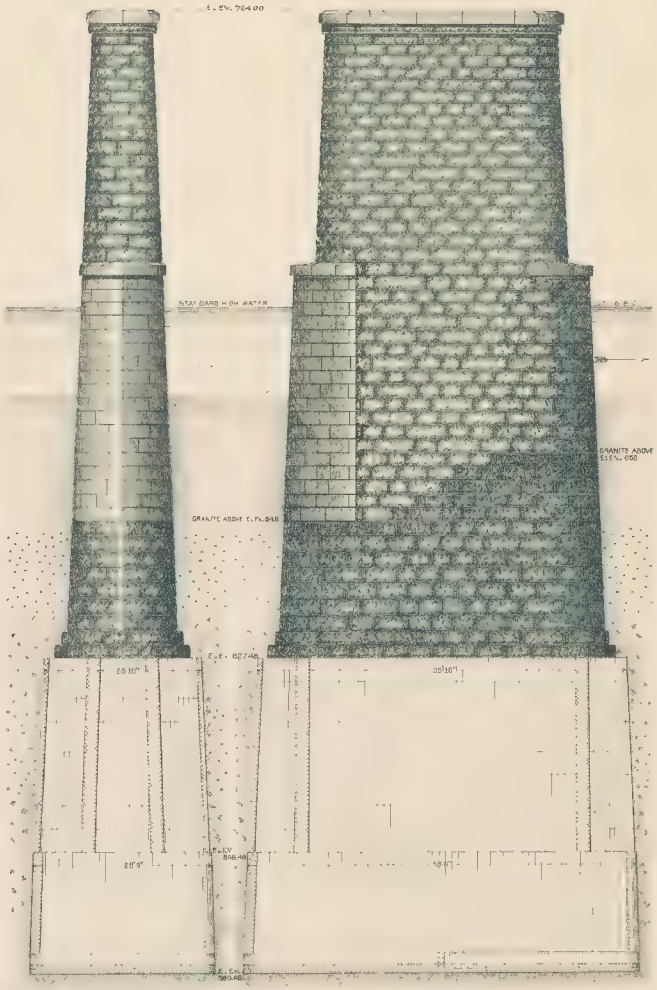
PIER Nº V.
END ELEVATION



PLAN PIER Nº V.



PIER Nº IV
PLAN

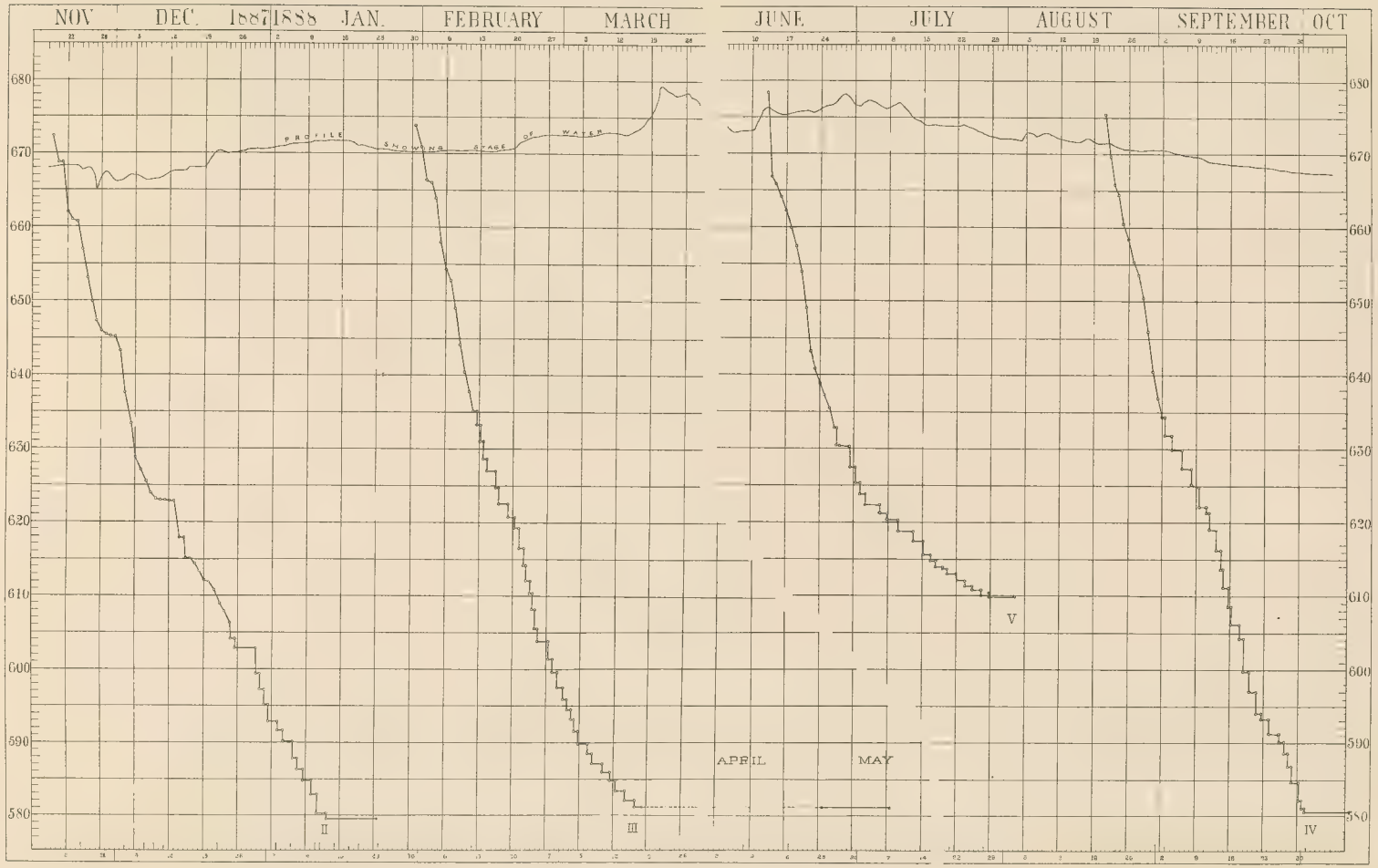


PIER Nº IV
END ELEVATION

PIER Nº IV
SIDE ELEVATION

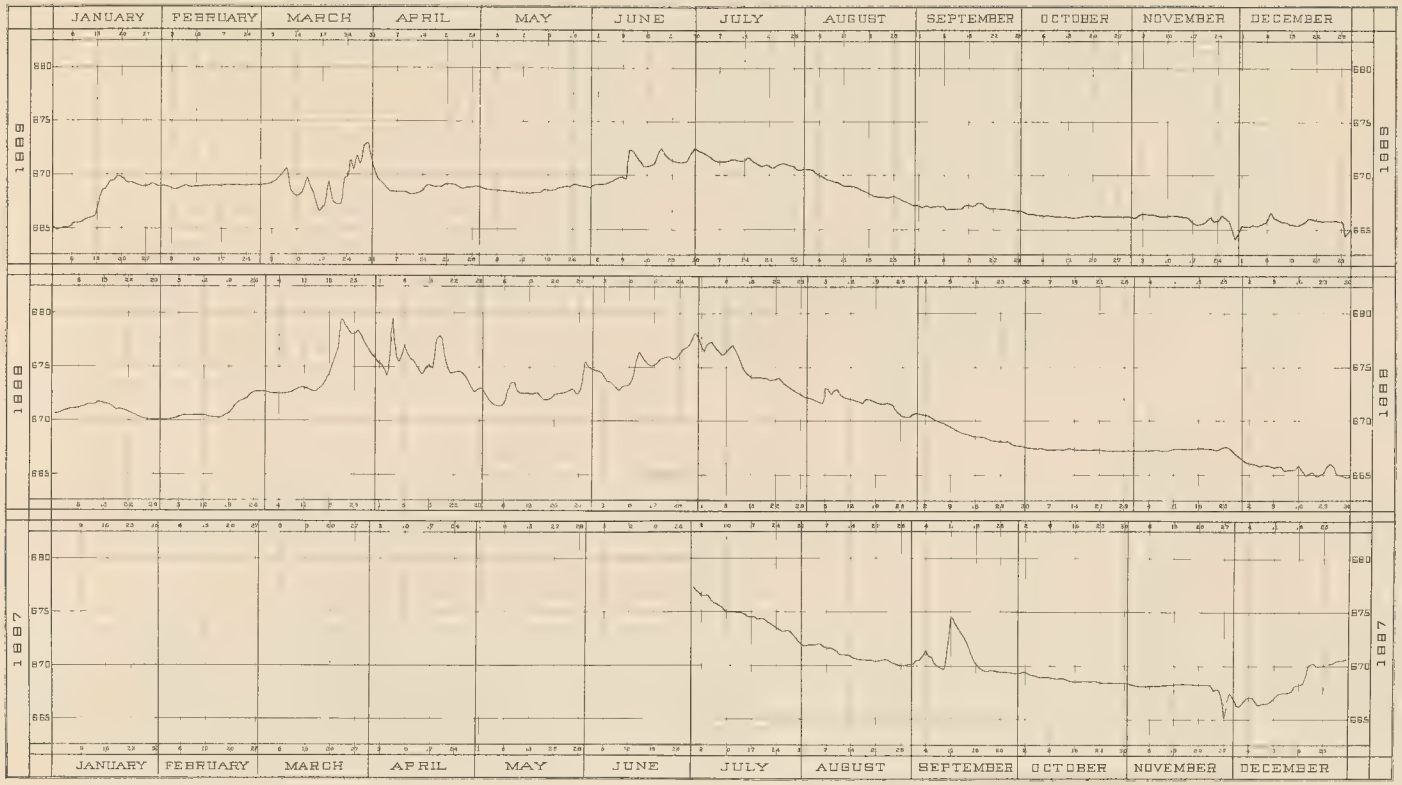
S.C.B.CO.

DIAGRAM SHOWING RATE OF PROGRESS IN SINKING CAISSONS



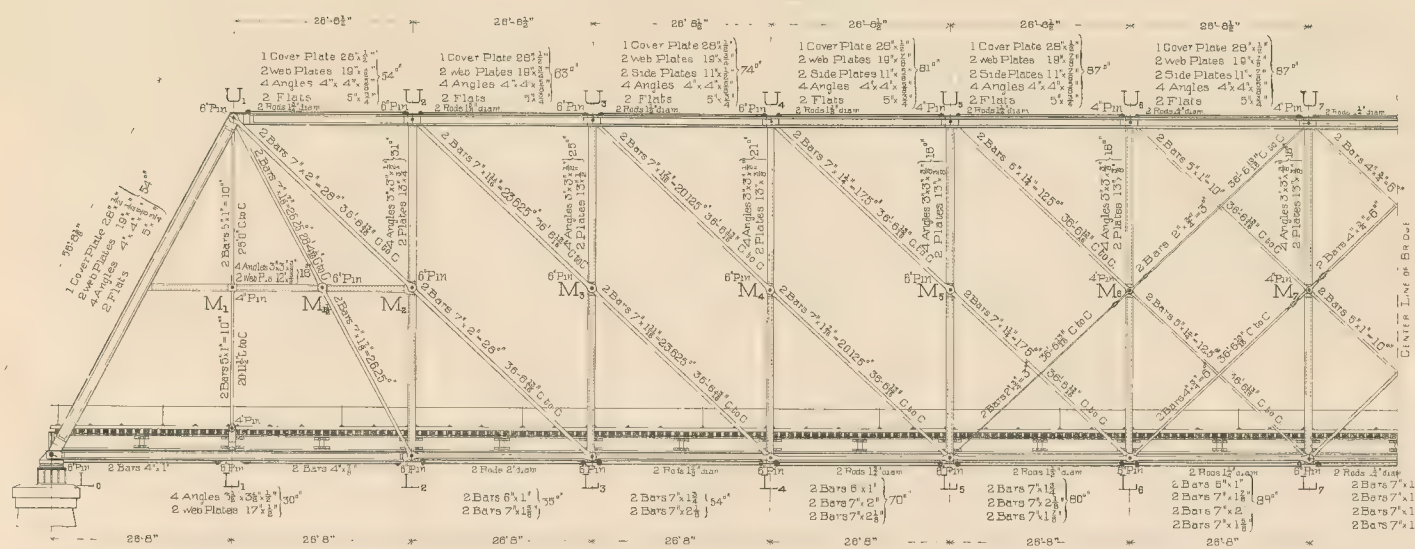
S.C.B.CO.

RECORD OF WATER STAGE OF THE MISSOURI RIVER



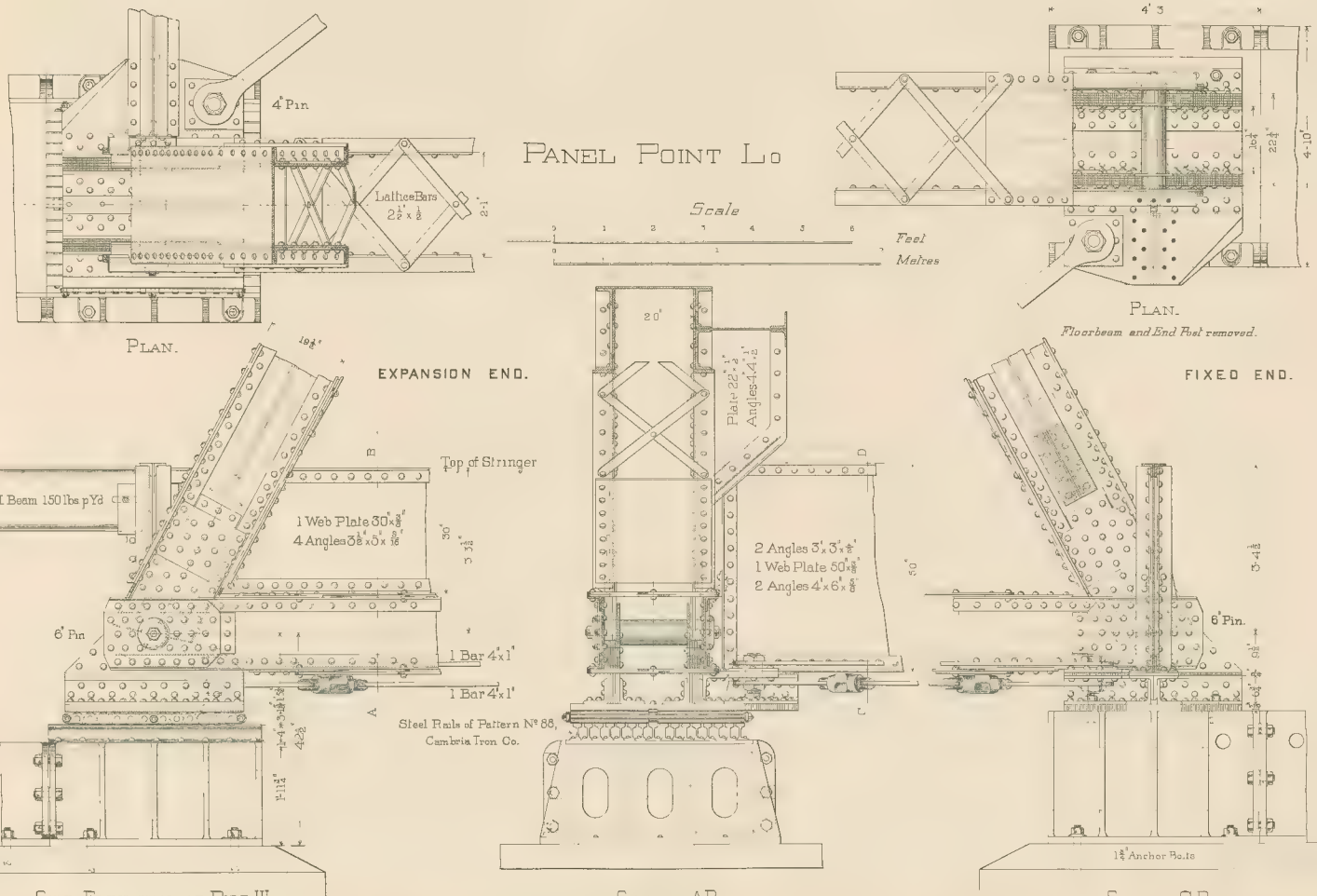
S.C.B.CO.

GENERAL ELEVATION OF 400 FT SPAN.



S.C.B.CO.

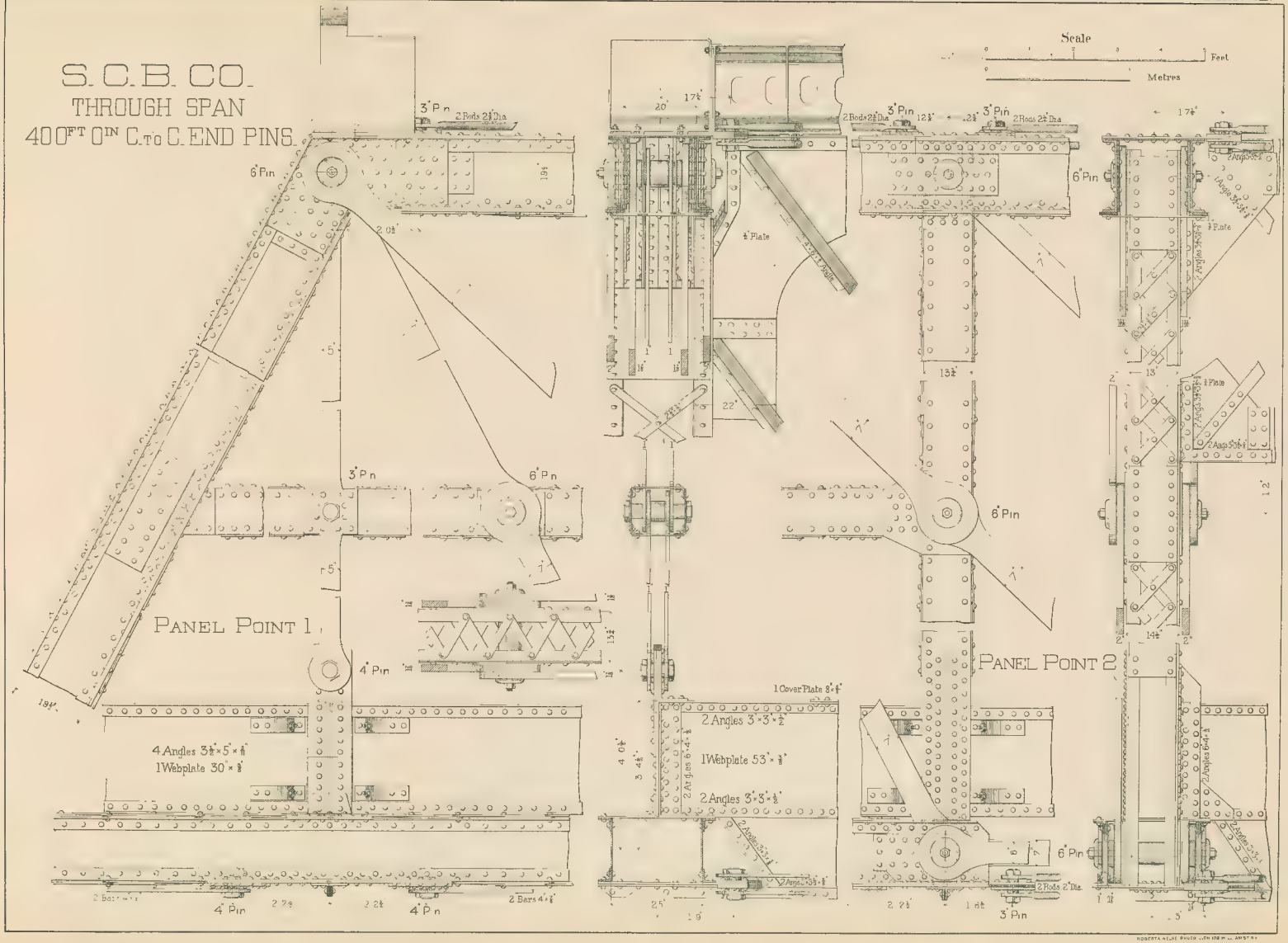
THROUGH SPAN 400FT 0IN C. TO C. END PINS.



S.C.B. CO.

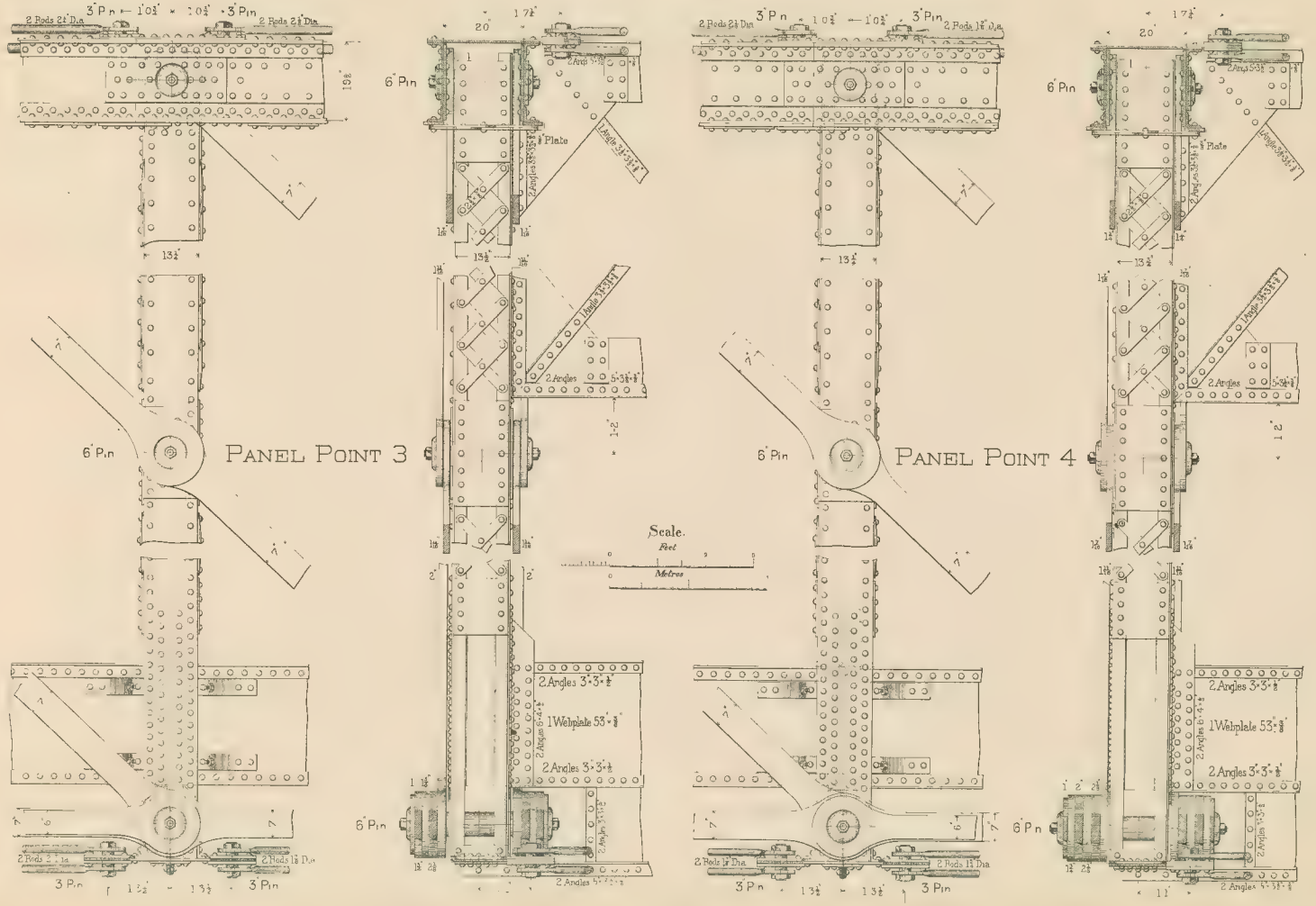
THROUGH SPAN

400FT 0IN C. TO C. END PINS.



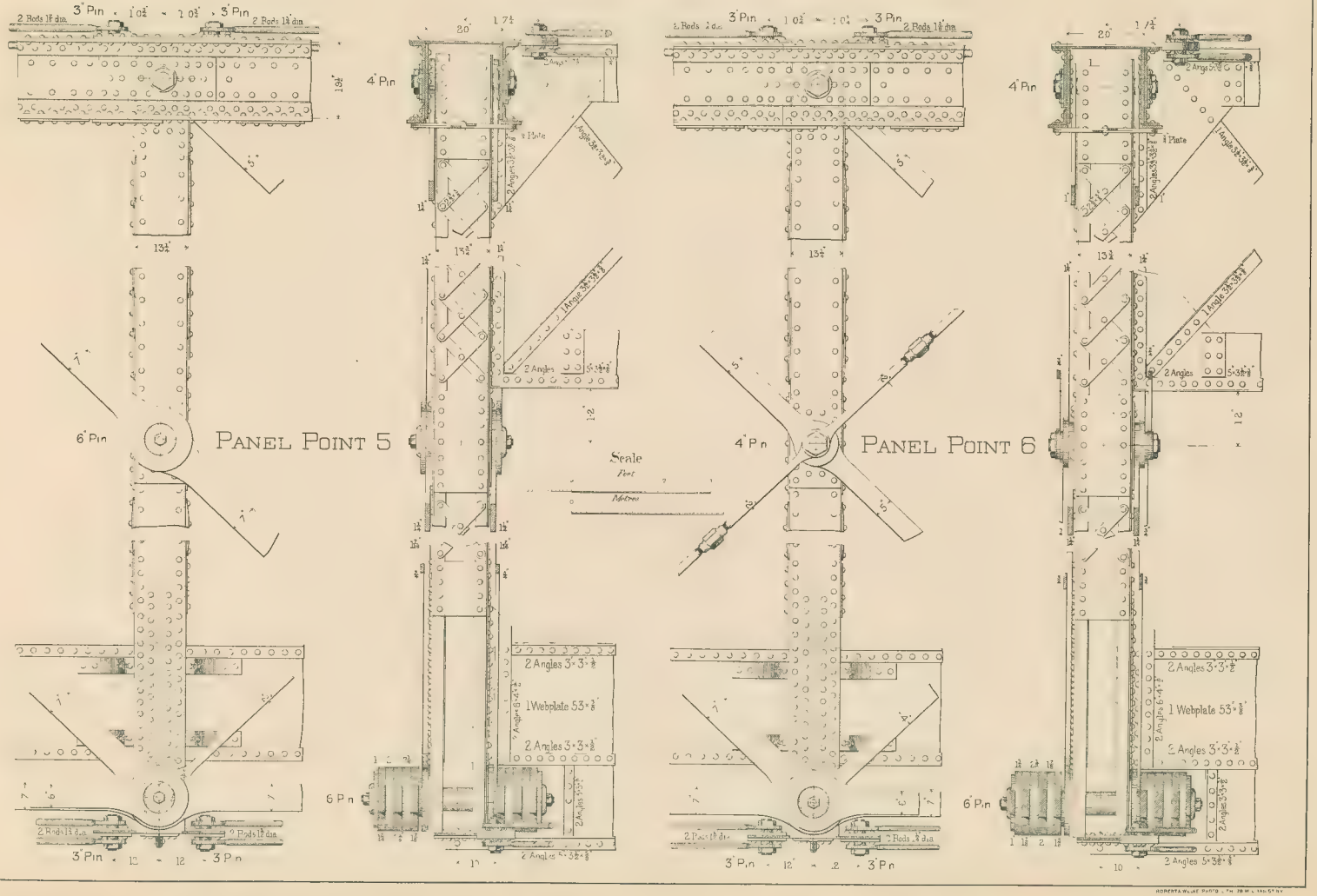
S. C. B. CO.

THROUGH SPAN. 400FT 0IN C. TO C. END PINS.



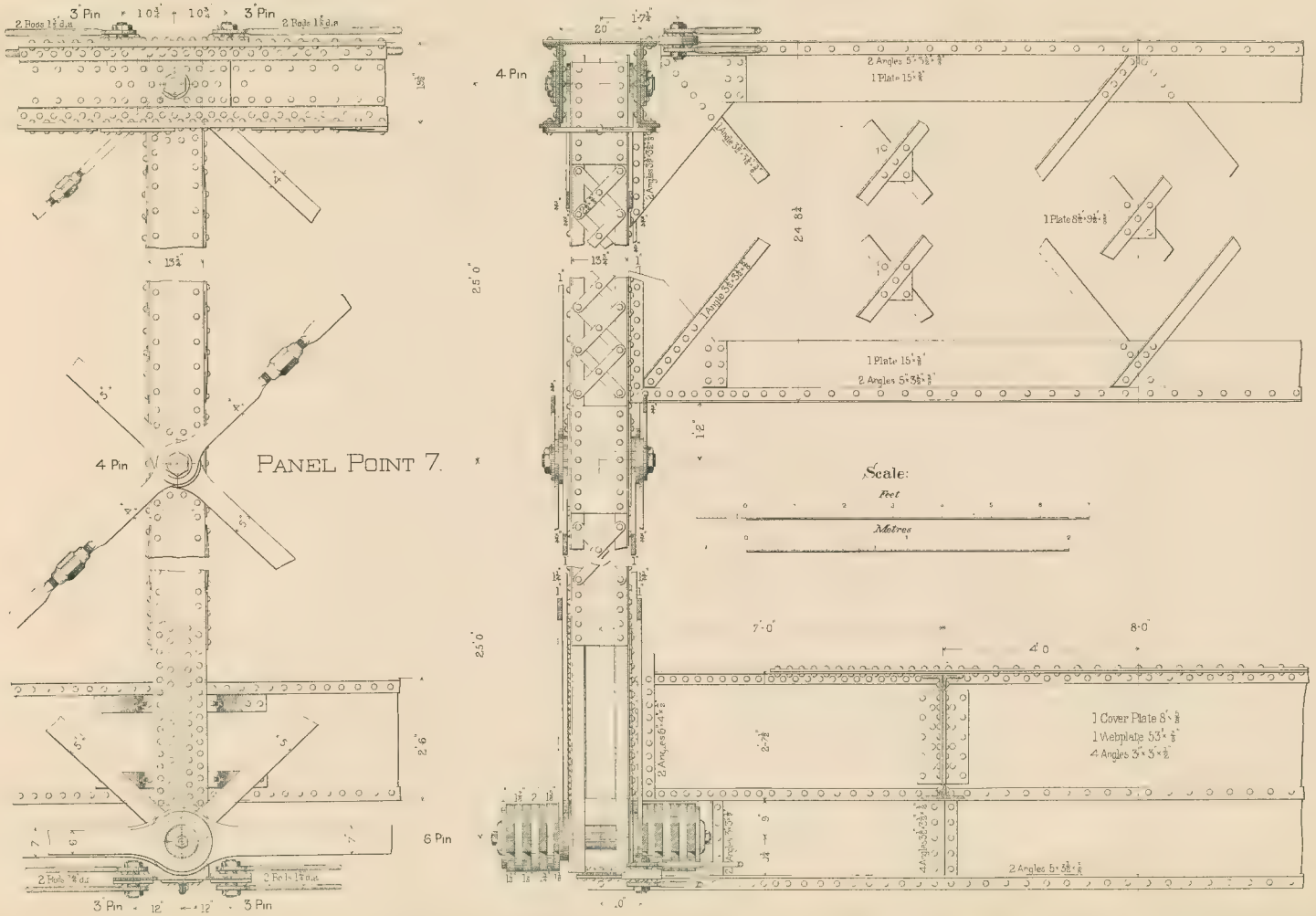
S. C. B. CO

THROUGH SPAN 400FT 0IN C. TO C. END PINS.



S.C.B CO.

THROUGH SPAN 400FT 0IN C. TO C END PINS.

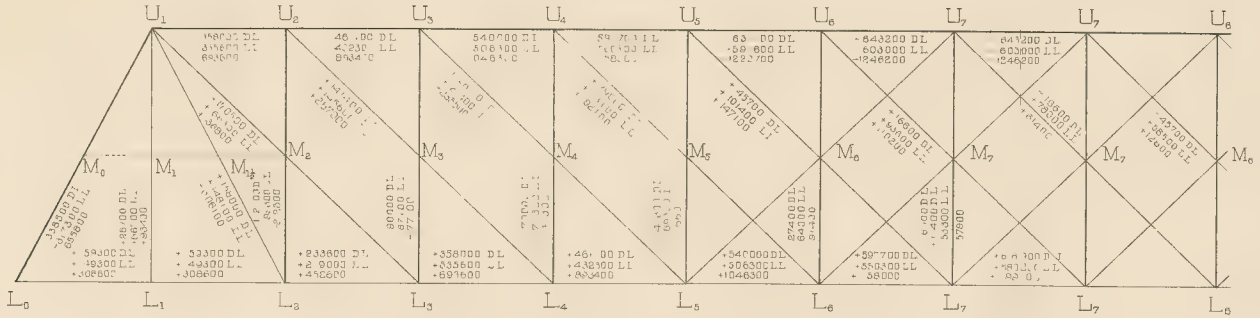


S.C.B.C.O.

400 FT THROUGH SPAN

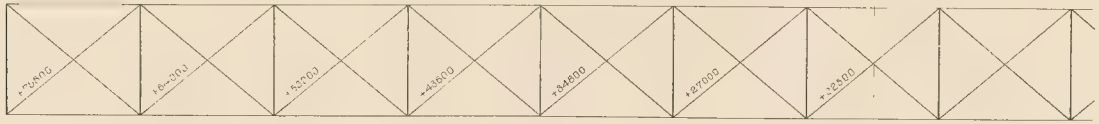
STRAIN SHEET

Assumed Loads
D.L. 3200 lbs. pr ft of Bridge
L.L. 3000 " " " "
E.L. 5000 " " " "

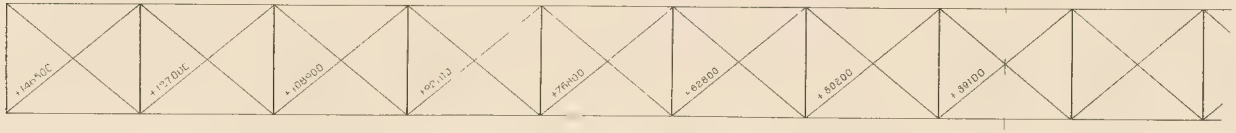


Center Line.

TOP LATERAL SYSTEM



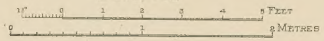
BOTTOM LATERAL SYSTEM

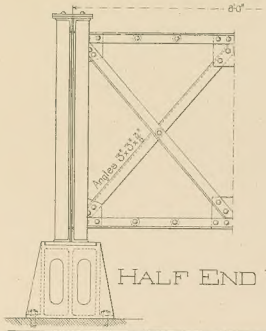


S.C.B.CO.

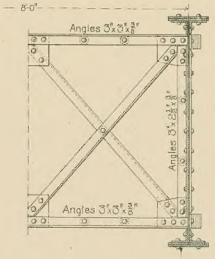
DETAILS OF 61FT 6IN PLATE GIRDER

SCALES

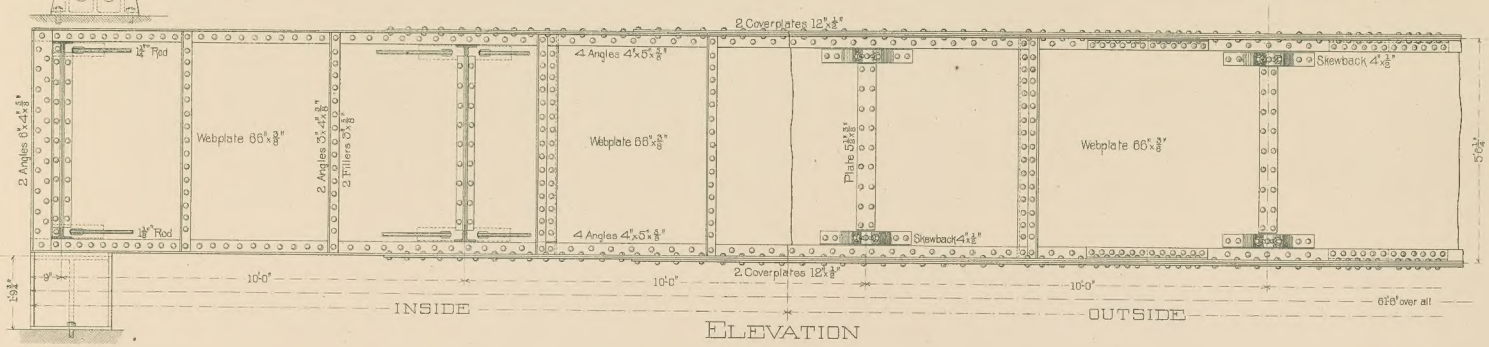




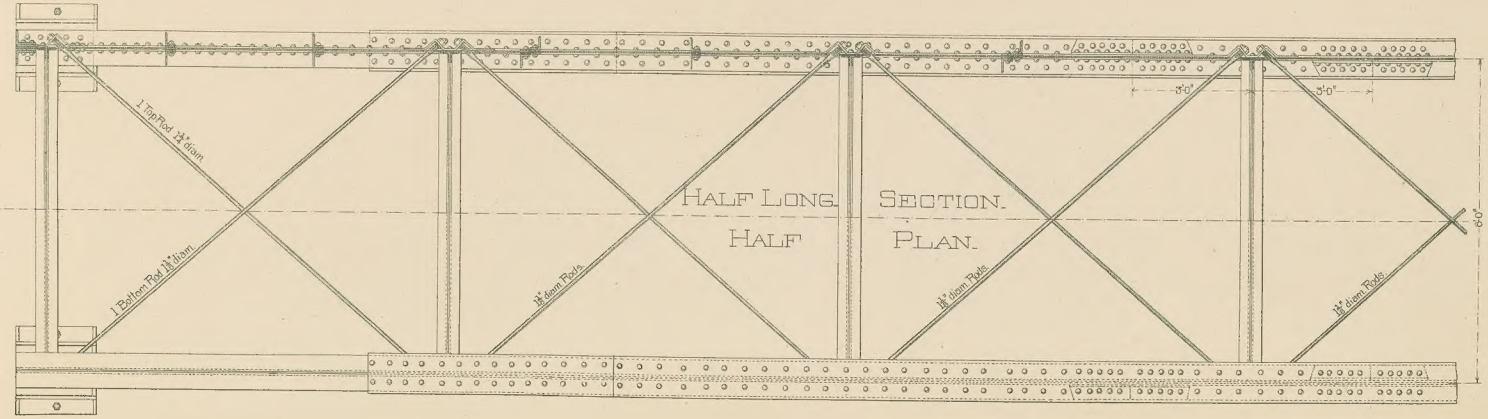
HALF END VIEW.



HALF CROSS SECTION.



ELEVATION



HALF LONG. SECTION. HALF PLAN.